TABLE DES MATIÈRES

LISTE DES TABLEAUX

Page

LISTE DES FIGURES

Page

LISTE DES ABRÉVIATIONS, SIGLES ET ACRONYMES

AHP	Analysis Hierarchical Process
AMC	Analyse Multicritère
CASBEE	Comprehensive Assessment System for Built Environment Efficiency
CASBEE-UD	Comprehensive Assessment System for Built Environment Efficiency – Urban Development
BRE	Building Research Establishment
BREEAM	Building Research Establishment Environmental Assessment Method
DES	Design
ENV	Environnement
EPA	Environmental Protection Agency
FAO	Food and Agriculture Organization
GES	Gaz à Effet de Serre
GIEC	Groupe d'experts Intergouvernemental sur l'Évolution du Climat
GIS	Geographic Information System
HAP	Hydrocarbures Aromatiques Polycycliques
IEA	International Energy Agency
iiSBE	International Initiative for a Sustainable Built Environement
INN	Innovation
IPCC	Intergovernmental Panel on Climate Change
JSBC	Japan Sustainable Building Consortium
LEED	Leadership in Energy and Environmental Design
LEED-NC	Leadership in Energy and Environmental Design - New Construction
LEED-ND	Leadership in Energy and Environmental Design - New Development
LOC	Localisation
LR	Load Reduction
NRTEE	National Round Table on the Environment and the Economy
OS	Objectif Spécifique
OG	Objectif Général
ONU	Organisation des Nations unies

OMS	Organisation Mondiale de la Santé
QUD	Environmental Quality Urban Development
PSR	Pression État Réponse
SB Tool	Sustainable Built Tool
SIG	Système d'Information Géographique
SOC	Social
TRAN	Transport
US	United States
U.S.A	United States of America
US EPA	United States Environmental Protection Agency
UN	United Nations
USGBC	United States Green Building Council

INTRODUCTION

Dans les processus d'urbanisation des communautés durables, les parties prenantes, dès les premières phases d'expansion de la ville, développent des formes d'aménagement innovatrices du territoire. La revitalisation des friches urbaines représente une opportunité intéressante au développement de ce type de projets. Toutefois, le défi est de trouver une manière de concilier les attentes et les objectifs de la ville, des investisseurs, des habitants et des organismes locaux. La revitalisation des friches industrielles s'inscrit de plus en plus dans la volonté des villes de densifier les activités sur leur territoire afin d'une part, d'augmenter la valeur foncière de ces terrains et donc de ses revenus et d'autre part, de réduire l'étalement urbain. La volonté de diminuer les distances de déplacement domicile-travail vise à réduire les temps de déplacement et les émissions de gaz à effet de serre, notamment par une utilisation accrue des transports en commun et à contribuer à la préservation des terres agricoles en périphérie des villes (Hyra, 2012, 2015).

Selon une estimation de l'Environmental Protection Agency (EPA, 2004) des États-Unis, il y a environ 450 000 friches industrielles, alors que la US Conference of Mayors (2006) avance plutôt le chiffre à 600 000 sites. Au Canada, il y a environ 35 000 sites contaminés selon la Table ronde nationale sur l'environnement et l'économie (NRTEE, 2003). La plupart de ces sites sont localisés dans les agglomérations urbaines de Montréal, Toronto et Vancouver (De Sousa, 2003). Le réaménagement de ces espaces est une tâche complexe en raison des effets induits sur les interactions avec les services et fonctions offerts par les milieux urbains auxquels ils se connectent. De nouvelles zones industrielles et entrepreneuriales sont créées en conformité avec les politiques visant à attirer les investissements privés à l'aide d'incitatifs pour les petites et moyennes entreprises (De Sousa, 2006). Cependant, il existe une certaine réticence à revitaliser ces espaces qui est causée par l'inertie des instances publiques locales et les différents paliers gouvernementaux à initier des processus de réaménagement, en raison du faible niveau de compréhension et d'acceptation des approches participatives et collaboratives nécessaires dans la conduite de projets complexes (Tonin,

2014). L'implication des parties prenantes est essentielle pour définir des stratégies de revitalisation des friches industrielles et pour réconcilier ces stratégies avec celles de la ville.

Les approches utilisées pour la prise de décision par les municipalités qui visent l'implication des parties prenantes préconisent une utilisation plus efficace des terres et misent sur l'amélioration des modes de transport autant au niveau de la fiabilité du service, du confort des usagers que de la diversité de l'offre de transports disponibles pour les déplacements (Cundy et al., 2013; Greenberg & Lewis, 2000; Luederitz, Lang, & Von Wehrden, 2013; Moussiopoulos, Achillas, Vlachokostas, Spyridi, & Nikolaou, 2010). Elles sont complémentaires, au sens où chacune met l'accent sur l'une des problématiques comme l'accessibilité, les activités économiques, le transport, les ressources environnementales, les relations entre les personnes et les politiques de logements, à savoir la capacité d'une ville à offrir à ses habitants des biens et des services et des activités en fonction de leurs besoins. Autrement dit, aucune des approches n'englobe toutes ces problématiques à la fois (Nijkamp, Rodenburg, & Wagtendonk, 2002; Pediaditi, Doick, & Moffat, 2010). Une caractéristique commune de toutes ces approches est de transformer le processus du développement des nouveaux quartiers ou de réaménagements des friches industrielles (Ng, Cook, & Chui, 2001; Turcu, 2013), par la conception de nouvelles approches d'aide à la décision (Marsal-Llacuna & Segal, 2017). Plusieurs d'entre elles sont fondées sur des principes généraux applicables dans différents contextes (Moussiopoulos et al., 2010; Pediaditi et al., 2010; Sardinha, Craveiro, & Milheiras, 2013). En outre, les méthodes d'évaluation les plus couramment utilisés (BREEAM, 2015; CASBEE-UD, 2014; LEED-ND, 2015; SBTool, 2004) ne sont pas tous équivalents ils ont une structure complexe et ne fournissent pas les résultats attendus dans l'analyse des projets de friches industrielles (Cappai, Forgues, & Glaus, 2016).

La recherche présentée dans cette thèse tout d'abord analyse les outils d'évaluation existants afin de relever et identifier les points forts et les points faibles de chacun pour ensuite proposer une série d'indicateurs locaux qui seront utilisés dans un outil d'évaluation, c'est-à-dire, une approche méthodologique pouvant être utilisée dans des projets de revitalisation des friches industrielles.

Objectifs de la recherche

La question principale de notre recherche est la suivante :
« Quels seraient les indicateurs socio-économiques et territoriaux reflétant les attentes des habitants et comment les intégrer dans un outil d'évaluation pour la conception d'un quartier durable? »

L'objectif principal est donc:
« Développer une méthode d'évaluation environnementale pour la réhabilitation des friches industrielles qui intègre des indicateurs socio-économiques pour réduire les impacts négatifs tout en répondant aux attentes des utilisateurs ».

Pour répondre à l'objectif général, les trois objectifs spécifiques sont les suivants :
1) Élaborer une grille d'indicateurs socio-économiques dédiée à l'évaluation d'un projet de réhabilitation d'une friche industrielle;
2) Établir les rôles des parties prenantes à chaque étape du cycle d'un projet de réhabilitation;
3) Évaluer la pertinence de l'intégration des indicateurs sélectionnés dans un processus d'évaluation de territoire.

La démarche de recherche proposée est guidée par l'élaboration d'une méthode qui se base sur l'intégration des indicateurs socio-économiques dans les outils d'évaluation d'aide à la décision. La méthode se base sur le choix d'indicateurs locaux qui se concentre sur les trois objectifs spécifiques pour la construction d'un quartier durable. Le nombre d'indicateurs locaux qui sont associés à ces objectifs permet de construire un outil capable d'évaluer la durabilité du quartier et de le contextualiser à la ville. Cette méthode permet d'évaluer la prise de décision sur un territoire défini, par exemple une friche industrielle. Elle s'appuie sur l'utilisation des méthodes d'analyse d'aide à la décision pour évaluer les alternatives proposées à travers l'utilisation d'un Système Informatique Géographique (SIG) pour évaluer la forme urbaine. La méthode proposée est inspirée des outils d'évaluation les plus connus

(CASBEE, LEED et BREEAM) dans le cadre de la construction. Ces normes reposent sur la gouvernance, sur les attentes des parties prenantes et sur les bonnes pratiques de construction durable.

A partir de ces considération notre attention s'est concentrée dans l'utilisation des espaces inutilisés et plus précisément dans les friches industrielles qui se trouvent désormais à l'intérieure de la trame urbaine. Les trois projets considérés se situent dans la friche industrielle du canal Lachine à Montréal qui a subi une transformation du territoire à cause de l'expansion industrielle dans les années 1920 et dans quatre arrondissements de la Ville de Montréal. Cette partie du territoire sera revitalisée en fonction des attentes des habitants et d'autres parties prenantes concernées. A cette fin, nous utiliserons une approche méthodologique que nous développerons pour analyser les améliorations apportées à ce territoire depuis les premières phases de réhabilitation du site jusqu'à aujourd'hui.

La principale contribution de cette recherche est un artefact pour résoudre les faiblesses contenues des outils d'évaluation les plus connus et d'en évaluer la performance dans toutes les phases du projet (conception, rentabilisation, réalisation, utilisation). En outre, les indicateurs utilisés devraient pouvoir guider les solutions possibles dans les problématiques relatives aux projets d'aménagement du territoire et aider à prendre en compte les impacts potentiels sur l'environnement.

La thèse est organisée en six chapitres. Le premier chapitre aborde l'état des connaissances associé au contexte de la recherche, à la revitalisation des friches industrielles basée sur les connaissances théoriques et les expériences pratiques, aux motivations de la recherche, à la conception et les résultats. Le deuxième chapitre explicite la démarche méthodologique ainsi que les chapitres 3, 4 et 5 sont consacrés à la présentation des articles publiés et chacun d'entre eux répond à un objectif spécifique. Dans le sixième chapitre est consacré à la discussion générale de la thèse, l'originalité des travaux, les limites et un aperçut des travaux futurs. Enfin, dans le septième chapitre sont contenues les conclusions.

CHAPITRE 1

ÉTAT DES CONNAISSANCES

Ce chapitre présente la problématique de développement urbain en regard des indicateurs sociaux, environnementaux et économiques. À partir des problématiques, sera discuté le réaménagement des sites contaminés qui constitue une opportunité d'expansion de la ville et, enfin, le chapitre se conclu avec les défis liés aux objectifs socio-économiques et environnementaux des municipalités et de ses citoyens. Le chapitre décrit comment les indicateurs pour la prise de décision sont inscrits chacun à leur propre façon dans les différents outils et méthodes d'évaluation. Il décrit aussi les faiblesses de ces outils pour l'évaluation environnementale d'un quartier. Le chapitre conclue avec un résumé des différentes techniques utilisées pour le choix des indicateurs.

1.1 Évolution des villes

Avant le développement de l'automobile qui a transformé les villes et les métropoles contemporaines, la ville de l'époque préindustrielle a d'abord été bâtie à l'échelle des piétons et des chevaux. Ce n'est que par la suite, avec le développement du train, et plus tard du tramway, que nous avons eu des formes urbaines et métropolitaines particulières (Clark, 2010; Anne Henry, 2012). Le constat est que les grandes avancées techniques ayant marqué l'histoire de l'industrie ont eu des conséquences sur l'évolution de la ville. En effet, l'évolution des axes de communication, la mécanisation des procédés de fabrication et l'électrification des villes et des transports ont permis un développement sans précédent (Anne Henry, 2012). Avec ce concept d'urbanisme moderne, qui préconisait de diviser la ville par fonction, des nouveaux modes de transport, notamment l'automobile individuelle, l'aspiration collective à des environnements moins urbains, la croissance économique et l'accès à de l'énergie en abondance et à bon marché sont d'importants facteurs qui ont favorisé par la suite la généralisation et l'application de la pensée moderniste. La division de la ville par fonction a causé des problèmes environnementaux et socioéconomiques à cause

de l’expansion territoriale exagérée et la dépendance envers l’automobile. Encore aujourd’hui les villes sont dépendantes de l’utilisation de l’automobile, elles sont développées en districts monofonctionnels et les équipements et les services sont axés sur l’utilisation de la voiture individuelle (Hyra, 2015; Ewing et coll., 2016).

L'aménagement du territoire par les municipalités et les lois visant à aider les urbanistes ne laissent aucune marge de manœuvre aux autorités chargées de l'aménagement urbain pour permettre une utilisation durable des territoires. En effet, même si les villes sont orientée à l’utilisation des méthodes participatives, ses lois et règlements sont très rigide surtout dans les zones des sites industriels abandonnés à cause de leur passé. Cette rigidité est inadaptée à la nouvelle réalité urbaine, tant au niveau d’arrondissement que des zones où les nouveaux défis du développement durable peuvent être mis en place, ce qui pourrait favoriser la combinaison d'activités dans une perspective de complémentarité (Maciocco, 2008). En réalité, le manque de planification stratégique a contribué à la séparation exagérée et artificielle des diverses fonctions sur le territoire, ce qui a eu pour conséquence de contribuer à l'expansion urbaine c’est-à-dire à l’étalement urbain (Hyra, 2015).

Plusieurs acteurs sont d’accord que la ville doit tirer profit de la mixité et de la diversité de ses fonctions, non pas de leur séparation. En Amérique du Nord, par exemple, le mouvement de nouvel urbanisme a comme principe la favorisation de la mixité et l’intégration harmonieuse des diverses fonctions urbaines où les collectivités peuvent améliorer la qualité de vie ces habitants.

La Figure 1.1 présente l’évolution de la forme urbaine de deux villes françaises.

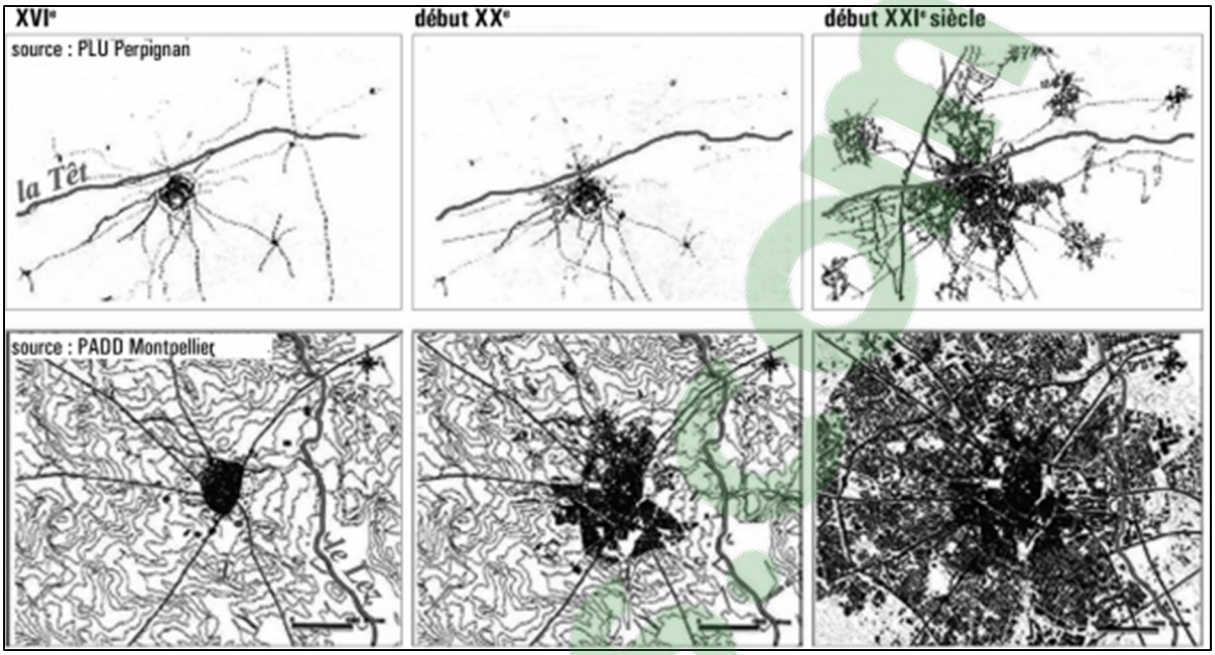

Figure 1-1 Évolution des villes de Perpignan et Montpellier au cours des cinq derniers siècles
Tirée de la ville de Perpignan et Montpellier, (2019)

Le déplacement de la population en périphérie des villes, autrement dit l'étalement urbain, est également un processus de différentiation fonctionnelle et sociale de la ville qui entraîne une répartition hétérogène et répondant principalement à des critères économiques des activités et de la population sur le territoire (Bramley, 2009). Cela a généré plusieurs impacts, notamment une augmentation du temps de déplacement et des problèmes psychologiques et physiques des personnes, à cause des changements des habitudes de vie (Ewing et coll., 2016). Cette situation de s'établir dans la banlieue, qualifiée de périurbanisation, est ainsi la cause d'importants problèmes sociaux et économiques qui touchent les sociétés actuelles.

Ces comportements sont à mettre notamment en relation avec la croissance du niveau de vie, le désir d'accès à la propriété, les possibilités offertes par la motorisation, la dégradation de la qualité du cadre de vie dans les centres villes (Hyra, 2015; Steigemann, 2010). Ces changements se traduisent par une mobilité individuelle croissante qui nécessite la construction de nouvelles infrastructures de transport ce qui, en soit, est déjà une contribution à l'étalement urbain (Da Cunha et coll., 2007). Par contre un étalement du bâti conduit à une diminution de la densité des agglomérations et, en même temps, à un accroissement

généralisé des déplacements (Hyra, 2015). Les inégalités croissantes de revenus entre les familles et le manque d'accès aux logements, a généré des impacts sur la qualité de vie des citadins (Thomas Piketty, 2014 cité pas Ewing et coll., 2016). En réponse à ces inégalités, une portion de la population urbaine, est obligée à se relocaliser en périphérie soit par obligation, soit pour être en mesure d'accéder à une propriété (Hyra, 2015).

En parallèle à cette migration vers la banlieue, s'ajoute la migration des populations rurales vers la ville. À partir des années 1960, la population a assisté à un autre flux migratoire des habitants. Un flux causé par une inversion des déplacements de la population dans plusieurs villes nord-américaines et dans certaines métropoles des pays en développement (Chine, Brésil, Inde, etc.) (Birch, 2005, 2009 cités par Hyra, 2015). Ces dernières populations, à cause des mêmes problèmes sociaux et économiques, ont été obligées de s'établir dans les zones à proximité de la zone urbaine ou, les plus chanceux, à proximité du centre-ville. Cette tendance d'un retour à la ville des dernières années, influencé par la volonté de densifier les zones urbaines à l'aide de politiques incitatives, a entraîné dans une certaine mesure un renouvellement urbain (Hyra, 2012, 2015). Ces flux migratoires et la rapidité de déplacement de ces flux, donc l'augmentation de l'urbanisation, a été telle qu'elle n'a pas permis à la ville de s'y adapter et donc de pouvoir prendre en charge convenablement ces nouvelles populations (Clark, 2010). Les immeubles ont été construits rapidement pour répondre à la demande croissante des immigrants qui arrivaient dans les villes. Il est de même possible que les délocalisations du centre vers les couronnes urbaines soient liées à une structure inadaptée et à un volume insuffisant de l'offre immobilière à prix abordable dans les centres des agglomérations (Li et coll., 2014). La Figure 1.2 montre l'évolution de la population mondiale depuis les années 1650.

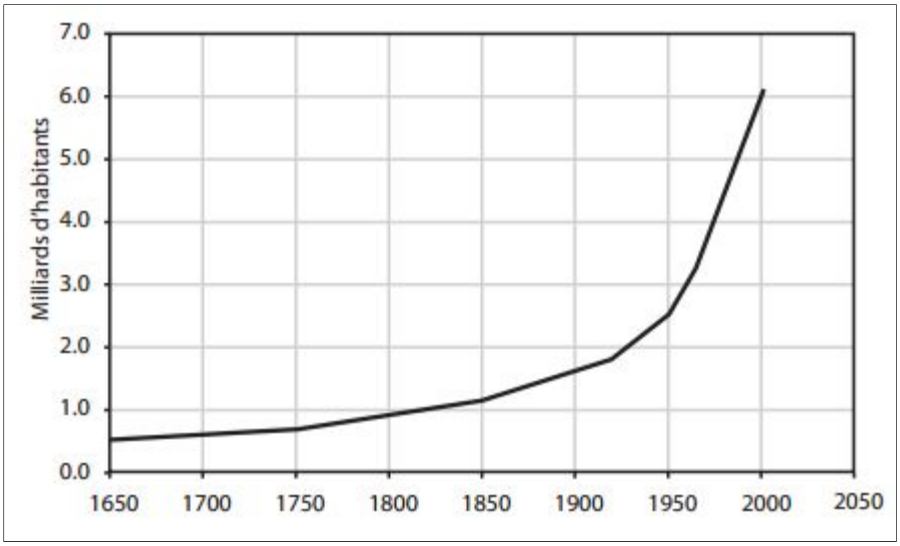

Figure 1-2 Évolution de la population mondiale

Le retour à la ville de ces flux migratoires a, entre autres, été la cause de la recherche de terrains à bâtir, notamment des terrains vacants ou inutilisés (Hyra, 2015). Tout cela et le manque de disponibilité d'espaces en ville est donc l'une des principales causes de l'augmentation de la valeur des terrains fonciers et des investissements que cette nouvelle population amène à la ville (Sturtevant et Jung, 2011 cité par Hyra, 2015). Cela peut expliquer le fait que dans les dernières décennies la population mondiale a eu une croissance exponentielle vers les villes. Plus de 50 % de la population mondiale vit dans les villes et elle occupe environ 2% du territoire (Banque Mondiale – Division de statistique Nations Unies, 2017). Par contre, le 75% de la population qui vive dans les pays développés et 40% de la population qui vive dans les pays en développement sont concentrées dans les villes. Ces proportions sont en constante progression. Par exemple, une étude mené en Amérique du Nord, prévoit que la population qui s'installera dans les villes atteindra les 2/3 dans les prochaine décennies (Banque Mondiale - Division de statistique Nations Unies, 2017) : tel qu'illustré dans la Figure 1.3, les projections estiment une population mondiale de 9,1 milliards en 2050 avec un taux d'occupation urbaine prévu à 70% (FAO, 2009; UN, 2010).

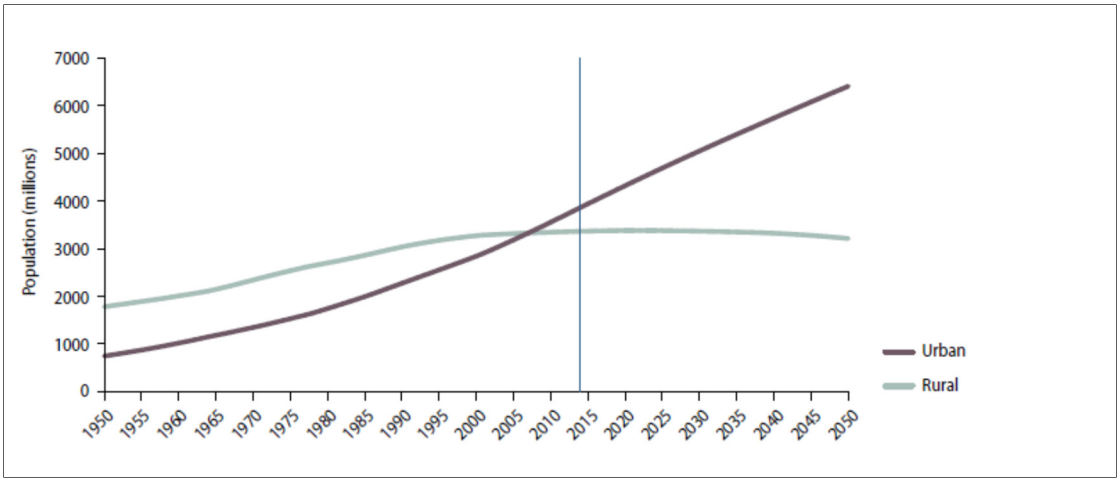

Figure 1-3 Évolution de la population mondiale rurale et urbaine (1950 – 2050)

1.2 Impacts environnementaux

Comme l'affirment Hyra (2015), Chen (2014) et Bramley & Power, (2009), la prise en compte des impacts environnementaux dans le cadre de la planification du territoire est nécessaire pour réduire: (1) l'étalement urbain et la perte de zones agricoles et forestières et (2) la transformation des zones naturelles en zones construites, que ce soient des bâtiments, des routes, des voies de chemin de fer, des parcs urbains, etc.. Bramley et Power (2009) ainsi que Holden (2013) suggèrent pour répondre à ces enjeux, que la planification des territoires urbains doit prendre en considération les terrains vacants ainsi que les espaces « abandonnés » qui sont présents sur le territoire urbain dans le but d'une réappropriation de ces friches afin de densifier et améliorer leur statut environnemental.

La construction, mais surtout l'exploitation du bâtiment (eau, éclairage, chauffage, entretien), entraîne la consommation de près de la moitié de l'énergie produite dans le monde. Le secteur du bâtiment et de la construction est l'un des secteurs les plus concernés par les enjeux environnementaux. Le secteur de la construction, selon une étude conduit par Deshayes (2012), est un des secteurs qui consomme le plus d'énergie. En effet, au niveau mondial, elle en consomme environ 37%.

Les activités humaines concentrées dans les villes en influencent le développement génèrent plusieurs sources de pollution. En outre, ces activités sont accompagnées par la

consommation excessive des ressources naturelles qui peut apporter des problèmes pour la population locale et pour l'environnement (Giaccone, 2017). En même temps, les villes dépendent de leurs écosystèmes pour maintenir les conditions de vie à long terme, la santé, la sécurité, de bonnes relations sociales, et d'autres aspects du bien-être humain (Gómez-Baggethun & Barton, 2013). Ainsi l'augmentation de la consommation sur le territoire, amplifiée par la libéralisation du commerce et des échanges non contrôlés, a non seulement accéléré l'épuisement des ressources naturelles en encourageant les villes à dépasser leurs limites locales mais, en plus, elle a contribué à l'augmentation des impacts environnementaux (Wackernagel & Rees, 1998).

1.3 Traces de l'industrie en milieu urbain

L'industrialisation au cours du XIXe siècle dans les pays occidentaux a donné lieu à une concentration des populations urbaines qui a transformé le tissu urbain. Cette urbanisation présente un caractère exponentiel depuis les années 1800 et qui semble être vécu comme une fatalité par la plupart des gouvernements et aménageurs (Wiel, 2000; Veron, 2006). L'industrialisation a été rendue possible par l'exploitation des territoires afin de satisfaire l'approvisionnement en ressources ainsi que la construction d'infrastructures pour la production et la distribution des biens. Par exemple, les usines furent construites à proximité des voies de transport, tels les ports et les chemins de fer, mais aussi près de canaux conçus pour le transport des produits de transformation. Aussi, il y a eu de nombreuses habitations construites pour les travailleurs à proximité des sites industriels. Les friches industrielles actuelles sont les traces des activités industrielles passées correspondant à des espaces sous-utilisés et difficiles à réaménager (De Sousa, 2006). En effet, l'intensité de l'activité industrielle du passé a contribué à la contamination de nombreux terrains, mettant ainsi un frein à la réhabilitation de certains sites et à la revitalisation de secteurs de la ville (Mathieu, 2011; Préfontaine, 2008).

Les friches industrielles peuvent être définies de plusieurs façons. Les définitions plus souvent utilisées incluent les éléments suivants: abandonné, contaminé, potentiellement

contaminé, vacant, sous-utilisé, écologiquement défavorisé. Les friches industrielles sont des propriétés situées dans des endroits entremêlés dans la trame urbaine et se démarquent généralement des sites vierges, c'est-à-dire terrains non développés (De Sousa, 2006; Wedding & Crawford-Brown, 2007). L'Environmental Protection Agency des États-Unis (USEPA) définit les friches industrielles comme « des propriétés dont la réutilisation peut être compliquée par la présence potentielle d'un contaminant ou d'une substance dangereuse ou polluante ». L'EPA définit les friches industrielles en regard principalement de l'aspect environnementale, par contre notre proposition tient compte du contexte urbaine. Nous suggérons cette définition qui résume les précédentes : « Les friches industrielles sont des terrains entremêlés dans la trame urbaine et, dû à leur patrimoine historique, des infrastructures existantes et pour leur situation dans la ville, ces terrains constituent une opportunité pour mettre en acte les enjeux sociaux, économiques et environnementaux en répondant aux attentes de la communauté locale ».

Aujourd'hui les friches industrielles sont devenues des territoires qui peuvent offrir de nombreuses opportunités de projets de requalification urbaine grâce à leur emplacement stratégique au sein de la ville (De Sousa, 2006). Car à cause de l'agrandissement des villes, elles sont souvent entremêlées dans les espaces urbanisés et elles représentent un intérêt particulier pour les bâtiments qui se trouvent sur le territoire de la friche industrielle notamment sur le plan architectural (Adams, Watkins, & White, 2005; De Sousa, 2006; Wedding & Crawford-Brown, 2007). Les projets de revitalisation urbaine représentent une opportunité de mise en valeur du patrimoine historique (Wedding & Crawford-Brown, 2007). Depuis une trentaine d'années, il y a une tendance accrue à la réappropriation de friches industrielles. C'est à partir des années 1970, que les nouveaux aménagements de friches industrielles prennent place. Les stratégies appliquées à cette époque par les décideurs en matière de planification et d'aménagement du territoire se focalisaient surtout sur l'aspect économique à réaliser, via les taxes locales, les emplois créés et les recettes fiscales escomptés (De Sousa, 2006). Ces réaménagements au début répondaient donc à des enjeux et à des stratégies de nature économique et, rarement, à des valeurs ou à des enjeux selon les attentes de la communauté locale. C'est à partir des années 1990 que les décideurs prennent

conscience du potentiel de redéveloppement de ces sites inutilisés, fondés sur des dimensions plus sociales et urbanistiques et plus ancrés dans les milieux locaux, ainsi que sur leurs atouts en termes de localisation (USEPA, 2009).

Récemment, les municipalités ont porté plus d'attention aux mesures destinées à favoriser le développement urbain durable et à améliorer la « qualité de vie » des citoyens (De Sousa, 2002). L'intérêt de la réhabilitation de ces sites repose non seulement sur la configuration et la composition architecturale du lieu, mais également de son environnement (De Sousa, 2006; Préfontaine, 2008). Cependant, tout projet de réhabilitation d'un site situé au sein d'un territoire urbain doit tenir compte des spécificités locales d'une part en s'intégrant aux infrastructures de service existantes et, d'autre part, en considérant les attentes des acteurs sociaux tant sur les plans du développement économique que des aspects sociaux (Tonin, 2014).

Il y a une relation étroite entre le réaménagement des sites contaminés, qui constitue une opportunité d'expansion de la ville, et les défis liés aux objectifs de la durabilité (Adams & White, 2005). Cette expansion des friches entraînera potentiellement des impacts positifs à cause du type de construction et la réduction de la consommation de ressources (remplissage des terrains vacants), des environnements de travail et de vie plus sains et la réduction des déchets de la construction (réutilisation des bâtiments existants) (US EPA, 2009).

Dans les dernières décennies, la réhabilitation des friches industrielles a été l'un des éléments les plus importants des programmes de développement des grandes villes occidentales, en particulier pour celles dont la conjoncture économique a entraîné la dégradation de la structure urbaine (Sardinha & Milheiras, 2013). Dans ce contexte, la réhabilitation de ces espaces a pu donner naissance à la production de nouveaux espaces verts publics sur les friches industrielles. La réhabilitation des friches industrielles peut entraîner les municipalités à donner un aspect dynamique, paysager et environnemental à leur territoire (Sousa, 2002). Il y a une relation étroite entre le réaménagement des sites contaminés, qui constitue une opportunité d'expansion de la ville, et les défis liés aux objectifs socio-économiques et

environnementaux des municipalités et de ses citoyens (Adams & White, 2005). Cette expansion des friches entraînera potentiellement des impacts positifs à cause du type de construction, de la réduction de la consommation de ressources (remplissage des terrains vacants), des environnements de travail et de vie plus sains et de la réduction des déchets de la construction (réutilisation des bâtiments existants) (US EPA 2009). De plus, de par leur localisation, leur réhabilitation permet de réduire la distance aux services et aux équipements tout en minimisant l'étalement urbain et en favorisant la mixité sociale (Sardinha & Milheiras, 2013).

1.4 Reconversion des friches industrielles en quartiers durables : Exemples en Europe et Amérique du Nord

Tel que mentionné plus haut, les friches industrielles sont des espaces qui doivent être privilégiées pour la réalisation des quartiers durables (Sousa, 2002; Tonin, 2014; Cappai et al., 2018). La reconversion des friches industrielles en quartiers durables est commencée dans plusieurs pays de la Communauté Européenne; d'abord dans les Pays-Bas et successivement, en Allemagne et en Suède (Holden, 2009). La cible de reconversion de ces quartiers a été l'application des principes de durabilité, c'est-à-dire les principes de densité, de mixité pour favoriser l'échange des relations entre les citoyens et ceci dans le but de préserver la consommation du territoire et des terres agricoles en particulier.

Ces quartiers, plus connus sous le vocable d'éco quartiers, réalisés dans les pays d'Europe du Nord, ont reçu un accueil favorable et ont connu une popularité grandissante en raison de leurs principes de développement durable. Des études scientifiques ont critiqué la réhabilitation opérée dans ces friches industrielles dans le centre-ville ou à proximité, car elles ont fait augmenter les valeurs foncières et cela a souvent favorisé les classes aisées de la population (Da Cunha, 2007). Les quartiers les plus connus en Europe sont : le quartier Vauban en Allemagne, le quartier Bedzed à Londres et les quartiers suédois Hammarby Sjöstad et B001 à Malmö. Ces espaces présentent des similitudes dans leur conversion. L'objectif commun de reconversion qui a caractérisé l'aménagement de ces lieux a été de dépasser l'image de la ville industrielle, mais en laissant les traces qui ont caractérisé ces

espaces (bâtiments historiques et installations industriels) dans un souci d'en conserver l'esprit du lieu. Ceci se traduit, sur le plan architectural, par la réutilisation des ressources locales et des bâtiments présents dans les friches.

En Amérique du Nord, les projets de reconversion de friches industrielles en zones périphériques ont été réhabilitées en utilisant l'application à la fin des années 1990 des principes du nouvel urbanisme. Au Canada, les politiques de reconversion de ces sites industriels, jusqu'à aujourd'hui ne sont pas encore en mesure de concurrencer avec certains pays européens, tels le Royaume-Uni, l'Allemagne ou la Suède, qui se posent en avant-gardistes en matière de reconversion des friches, ni même les États-Unis, qui se présentent comme les plus actifs (De Sousa, 2002). Toutefois, depuis une dizaine d'années, au Canada il y a eu une multitude des projets de réaménagement de friches industrielles plutôt réussies (Tableau 1-1). Les réhabilitations des friches industrielles ont pris place à Hamilton, à Vancouver (site industriel de Fraser Mill), à Victoria (site portuaire Dockside Green), à Toronto (les entrepôts industriels et commerciaux des quartiers de King-Spadina et du Parlement reconvertis en espaces de mixité fonctionnelle et la restauration du Distillery District en lieu de rassemblement pour les acteurs du monde de l'art et de la culture).

À Montréal, le réaménagement des anciens bâtiments commerciaux du Vieux-Montréal, de Griffintown et des berges du canal Lachine, du quartier de la fourrure et la conversion des Ateliers Angus en 2500 espaces d'habitation, dont 40 % de coopératives et de logements sociaux en sont d'excellents exemples (De Sousa, 2006). Ceci dit, de tous les projets canadiens de reconversion de friches, ce sont les opérations de reconversion de bases militaires en quartiers durables réalisées par la Société immobilière du Canada (SIC) qui s'affichent comme les plus exemplaires en matière de durabilité urbaine.

Tableau 1-1 Les friches industrielles reconverties en quartiers durables au Canada

NOM DE LA FRICHE INDUSTRIELLE	VILLE	SUPERFICIE (HA)	RÉALISATION	VOCATION
Canal Lachine	Montréal, QC	9,6	1999 - 2020	Port intérieur
Campus Outremont	Montréal, QC	18	2010 – 2022	Gare de triage
Pointe-du-Moulin	Montréal, QC	8,5	2010 – 2017	Site industriel portuaire
Village de la gare	M. St-Hilaire, QC	73	2001 – 2012	Raffinerie de sucre
Faubourg	Boisbriand, QC	22	2005 – 2009	Usine d'assemblage
CFB Rocklife	Ottawa, ON	125	2011 – 2018	Base des Forces Canadiennes
Plaines Lebreton	Ottawa, ON	65	2004 – 2025	Site industriel
Metrogate	Toronto, ON	7	2006 – 2011	Terminal de camionnage
Perth Works	Perth, ON	1	2007	Site industriel
Preston Meadows	Cambridge, ON	4	2005 – 2008	Usine de tramways
Lower Don Lands	Toronto, ON	125	2011	Site industriel portuaire
Currie Barracks	Calgary, AB	81	2009 – 2019	Base des Forces canadiennes
Dockside Green	Victoria, BC	6	2006 – 2014	Site industriel portuaire
Garrison Crossing	Chilliwack, BC	62	2003 – 2007	Base des Forces canadiennes
Southeast False creek	Vancouver, BC	32	2001 – 2020	Site industriel
Station Pointe	Edmonton, AB	1	2008	Site industriel

En effet, pratiquement tous les projets de cette société d'État – qui gère, réaménage et vend des biens immobiliers stratégiques dont le gouvernement du Canada n'a plus besoin pour ses

programmes – ont connu un franc succès, tant auprès de la population locale que sur le plan international (obtention de la plus prestigieuse désignation, à savoir l'homologation LEED-neighborhood), avec des projets tels que les Casernes Currie à Calgary, le Village de Griesbach à Edmonton, le Garisson Crossing à Chilliwack ou encore les Bassins du Nouveau Havre à Montréal (Plan gouvernement du Canada, 2011; Ministère de l'environnement, 2012).

1.5 Outils d'évaluation et d'aide à la décision

Appliquer les notions du « développement durable » à la construction signifie la prise en compte globale de ses trois piliers (économique, environnemental et social). La difficulté d'application du principe de développement durable repose sur la complexité engendrée par le grande nombre de parties prenantes qui doivent s'entendre sur un projet en tenant compte de ces trois aspects en prenant en considération des indicateurs associés notamment à : la gestion de l'énergie, la diversité sociale, la qualité de l'air, les réseaux de transports, la qualité de l'eau, la gestion des déchets, l'aspect économique, le remplissage des terrains vacants, la sauvegarde des sites historiques, la rénovation du cadre bâti existant, etc. (Beekmans, Ploegmakers, Martens, & van der Krabben, 2015). Pour faire face à cette planification stratégique et répondre aux exigences des villes, des méthodes d'évaluation environnementale développées par des organisations publiques ou à but non lucratif ont été adoptées par certains pays (Angleterre, États Unis, Japon, Australie et certains pays de la Communauté européenne) pour les aider dans la prise de décision (Sharifi & Murayama, 2013; Talen et al., 2013). Au début des années 1990, la *Building Research Establishment* (BRE) a développé en Angleterre l'outil d'évaluation BREEAM ou *Building Research Establishment Environmental Assessment Method*. La première version pour l'évaluation des nouveaux bâtiments a été lancée en 1990. Elle a été suivie par des versions pour d'autres bâtiments, notamment des supermarchés, des unités industrielles et des bureaux existants. Après son lancement, le BREEAM s'est développé à une échelle plus large que celle d'un seul bâtiment, il a donné lieu à un autre outil appelé le BREEAM Refurbishment. Ce dernier a été développé pour évaluer les projets de rénovation de logements durables et ainsi pour

améliorer efficacement la durabilité et la performance des logements existants. Un autre outil a été créé mais cette fois à l'échelle du quartier et de la ville : le BREEAM Communities. Il est intéressant de souligner que cet outil permet d'évaluer aussi les friches industrielles (BREEAM, 2016). Les États-Unis ont commencé à utiliser à partir des années 1990 un outil d'évaluation pour répondre aux exigences de la communauté afin de réduire les impacts du cadre bâti sur l'environnement (Sharifi & Murayama, 2013). Initialement cet outil d'évaluation était conçu pour mesurer l'impact environnemental à l'échelle du bâtiment : il prévoyait en outre de réduire la consommation d'énergie. La U.S. *Green Building Council* (USGBC) a développé en 1993 la certification LEED-NC ou Leadership in Energy and Environmental Design - New Construction. Cet outil a été conçu pour la construction de nouveaux édifices. Dans LEED-NC, il y a plusieurs indicateurs qui permettent d'évaluer les aspects économiques et environnementaux du bâtiment (USGBC). En 2009, l'USGBC a développé le LEED-ND (New Development) qui est un programme indépendant de certification pour l'aménagement de quartiers durables, mais qui évalue aussi les friches industrielles. Cette échelle donne également la possibilité d'évaluer le projet en considérant les caractéristiques des bâtiments, la connectivité et densité du quartier et la contextualisation du site (USGBC, 2016).

Le Japon a développé en 2001 un système d'évaluation globale pour l'efficacité du milieu bâti (CASBEE). Le *Comprehensive Assessment System for Built Environment Efficiency* (CASBEE) est une méthode d'évaluation de la performance environnementale du bâti. Il a été développé par un comité de recherche grâce à la collaboration du monde académique, industriel, national et local qui a créé le *Japan Sustainable Building Consortium* (JSBC) sous les auspices du ministère du Territoire, des Infrastructures, des Transports et du Tourisme. CASBEE a été développé à l'origine pour l'échelle du bâtiment mais il s'applique maintenant aussi à l'échelle du quartier et de la ville (CASBEE-UD et CASBEE for Cities). CASBEE-UD est basé en référence aux éléments d'évaluation Q_3 (Environnement intérieur au site) et LR_3 (Environnement hors site). Cependant, CASBEE-UD est développé pour des groupes partiels ou entiers de bâtiments et se concentre sur les phénomènes qui peuvent survenir à la suite de la construction de conglomérats. CASBEE-UD exclut l'évaluation de

l'intérieur des bâtiments (bien qu'il y ait des exceptions dans certains éléments d'évaluation). Alors que, cette configuration permet d'utiliser CASBEE-UD pour évaluer une zone de développement dans son ensemble, CASBEE évalue la performance environnementale des bâtiments individuels dans la zone désignée et cela permet aux utilisateurs l'usage de CASBEE-UD aussi dans les projets de réhabilitation des friches industrielles (JSBC, 2016).

Le système d'évaluation *Green Star* a été lancé en 2003 par le *Green Building Council* d'Australie (GBCA, 2016). Ce système évalue la durabilité des projets à toutes les étapes du cycle de vie de l'environnement bâti. Les notations peuvent être obtenues lors de la phase de planification pour les communautés, pendant la phase de conception, de construction ou d'aménagement des bâtiments, ou pendant la phase opérationnelle en cours. La méthode permet d'évaluer les bâtiments, les aménagements et les collectivités par rapport à diverses catégories d'impacts environnementaux. Il vise à encourager le leadership dans la conception et la construction écologiquement durables et à promouvoir l'innovation dans les pratiques de construction durable et à tenir compte des économies de coûts.

Toutes ces méthodes visent à sensibiliser les propriétaires, les occupants et les concepteurs aux avantages d'adopter une approche de durabilité. Cela les aide à adopter des solutions durables de manière rentable et à reconnaître leurs réalisations sur le marché immobilier (Kaufman & Cloutier, 2006; Sev, 2011; Sharifi & Murayama, 2013). Elles visent à réduire les effets négatifs de la construction sur l'environnement. Cependant, ces méthodes d'évaluation ont des faiblesses, surtout pour l'utilisation des indicateurs mais aussi en ce qui concerne la participation des parties prenantes. Le tableau 1-2 indique la répartition des indicateurs dans chaque domaine de ces méthodes par rapport à l'évaluation d'un quartier.

Cependant, l'analyse a posteriori de la mise en application de ces méthodes d'évaluation tend à montrer qu'elles négligent les attentes des communautés locales et se concentrent à évaluer un aspect plutôt qu'un autre (Sharifi & Murayama, 2013; 2015). Par ailleurs, les indicateurs associés aux processus d'évaluation des friches industrielles sont centrés sur l'évaluation des retombées des projets à une échelle mondiale, nationale, régionale ou municipale; ils

minimisent les enjeux au niveau local (Bacot & O'Dell, 2006; De Sousa, 2006; EPA, 2004; Inoue & Katayama, 2011; Kaufman & Cloutier, 2006; Sharifi & Murayama, 2013).

Tableau 1-2 Répartition des indicateurs d'évaluation par catégorie pour les principales méthodes disponibles

Méthode d'évaluation	**Pays**	**Nb total d'indicateurs**	**Indicateurs utilisés dans chaque domaine (%)**					
			Tran	Env	Soc	Eco	Loc & des	Inn
BREEAM Communities	Angleterre	86	19	23	11	8	37	2
LEED-ND	États Unis	93	9	33	9	2	42	5
CASBEE-DU	Japon	66	10	41	6	0	43	0
Green Star Communities	Australie	79	12	33	15	2	37	1

Légenda : TRAN= Transport; ENV= Environnement; SOC= Social; LOC&DES= Localisation et design; INN= Innovation

Une méthode d'évaluation doit se concentrer sur ce qui est nécessaire et doit tenir compte de la spécificité du site. La réhabilitation des friches industrielles doit être capable d'analyser le site dans sa totalité et non seulement dans une dimension plutôt qu'une autre et se concentrer aussi au territoire. Par exemple, l'USEPA (2002), Northridge et coll. (2003), Hemphill, McGreal et Berry (2004), Balsas (2004), cités par Wedding & Crawford-Brown, (2007), ont proposé une méthode complète pour mesurer les impacts tant positifs que négatifs des projets de réhabilitation des friches industrielles. Les paramètres utilisés se concentrent peu sur les sites en question et négligent les questions sociales en faveur des questions économiques (Johnson & Whitlam, 1988; Wedding & Crawford-Brown, 2007; Inoue & Katayama, 2004, 2011; Sharifi & Murayama, 2013). Bacot et O'Dell (2006) ont également proposé des indicateurs pour mesurer les politiques de réaménagement des friches industrielles. Les indicateurs utilisés priorisent davantage l'environnement et les préoccupations économiques. D'autres études conduites par Lange et McNeil (2004) sur l'évaluation des interventions gouvernementales sur les friches industrielles ont utilisé des indicateurs qui se limitaient aux

impacts du réaménagement des friches contaminées, sans prise en compte des effets des projets sur la qualité de vie ou l'intégration de logements abordables ou sociaux. De plus, la démarche d'évaluation proposée s'applique à l'évaluation des friches après leur réhabilitation. Les travaux réalisés par De Sousa (2006) visant à évaluer l'impact de la réhabilitation des friches industrielles par l'entremise d'entrevues avec des intervenants de Milwaukee (États-Unis) ont mis en évidence que les projets sont évalués et justifiés sur la base de critères économiques. Les résultats des travaux ont par ailleurs montré que l'intégration des aspects environnementaux et sociaux amenait à améliorer la contextualisation des projets avec l'environnement existant. Dans ce contexte, de nombreux auteurs (Bond et Pope, 2012; Berardi 2013; Bond et Morrison - Saunders, et Howitt, 2013 cités par Sharifi & Murayama, 2013) suggèrent que l'évaluation de la réhabilitation de sites doit avoir un caractère multidimensionnel (social, économique, environnemental) qui reconnaissent les spécificités du contexte local et multi-acteurs afin d'intégrer les préoccupations des différentes parties prenantes de la société civile, notamment les citoyens concernés par le projet.

1.6 Choix des indicateurs : une démarche vers des indicateurs locaux

Dans le développement des indicateurs de durabilité en milieu urbain existent différentes approches et méthodes. Le choix des indicateurs dépend de l'approche utilisée et aussi de certains facteurs, notamment aux caractéristiques de la ville, du site spécifique, de la disponibilité des bases de données, ainsi que des niveaux de participation de la population au processus de planification et la gouvernance municipale. Les approches les plus connues dans le choix des indicateurs sont une approche systémique de type descendent et une approche systémique de type ascendante. Elles résultent d'initiatives avec l'engagement des citoyens (bottom up) ou par des autorités juridiquement compétentes (top down). Elles sous-tendent divers dispositifs d'inclusion des populations. Les moments où les habitants interviennent dans le processus de projet sont également à considérer pour qualifier les pratiques dans un processus d'aménagement urbain.

Quoique l'approche utilisée soit importante, reste à définir quels indicateurs reflètent et évaluent mieux le projet urbain. Plusieurs auteurs (Mori, 2012; Sardinha, 2013 et Sipioni, 2009) ont développé des méthodes différentes pour le choix des indicateurs afin d'arriver à une liste qui identifie et évalue mieux le contexte urbain pris en considération. À cet égard, Munier (2008), cité par Moussioupoulos (2012), a élaboré une méthode mathématique basée sur la programmation linéaire dans le but de maximiser la quantité d'informations contenues dans son ensemble des données et de déterminer des indicateurs locaux pour évaluer la durabilité urbaine. Dans son modèle, Munier (2008) a pris en considération les impacts directs et indirects de différentes composantes pour développer son cahier de calcul.

Des études similaires proposent des modèles de pondération ou des modèles statistiques pour l'élaboration d'indicateurs qui évaluent mieux la durabilité urbaine. Une étude menée par Scipioni (2009) sur la ville de Padoue en Italie a été faite en utilisant un ensemble d'indicateurs basé sur des ateliers et des discussions des groupes universitaires afin de parvenir à une liste d'indicateurs locaux pour l'élaboration du plan stratégique de la ville. Le processus d'élaboration des indicateurs comprenait différentes étapes pour arriver à la liste finale des indicateurs, entre autres pour prendre en considération des questions telles que le gouvernement politique, les limites urbaines du site, les agences gouvernementales impliquées, etc. Dans une autre étude menée par Schädler (2011), a été utilisé un modèle pour considérer les avantages économiques pour attirer des investisseurs dans les projets de réhabilitation urbaine. Dans ce cas-là, Schädler utilise des indicateurs en provenance des options de réhabilitation de plusieurs friches industrielles visant à soutenir une revitalisation efficace et durable pour aider les parties prenantes à la prise de décision. Schädler considère les coûts de décontamination du sous-sol et de préparation du site, une évaluation économique axée sur le marché et l'utilisation future prévit des sols pour le développement durable des communautés.

C'est évident que les villes, ainsi que de ses composantes (arrondissements, quartiers, friches industrielles) ont besoin d'une méthode basée sur l'avis des experts locaux pour développer l'ensemble d'indicateurs pour l'évaluation de la durabilité. La raison en est que, selon la

méthode utilisée, un ensemble de données spécifiques et rigoureuses sont requises, alors qu'un processus de gouvernance doit être pris en considération où les citoyens doivent participer au processus d'élaboration pour la prise de décision, afin de mieux contextualiser et mieux mettre en place une liste d'indicateurs locaux qui reflètent les attentes de la communauté locale.

La majorité des méthodes d'évaluation et des outils qui ont été développés ne prennent pas tous les aspects en considération et ceux-ci ne couvrent pas les problèmes dans lesquels la portée et le contenu des indicateurs locaux peuvent varier d'une région à une autre, même si l'objectif principal de chaque méthode d'évaluation consiste à déterminer la condition locale par la détermination des indicateurs. Une méthode plus efficace doit tenir compte des défauts et des limites des outils existantes et prendre en considération des indicateurs pour évaluer la durabilité en termes de toutes les dimensions, c'est-à-dire la dimension socio-économique, la dimension environnementale et la dimension institutionnelle et culturelle pour établir une planification efficace et stratégique du contexte évalué. Comme montré par différentes études le développement des indicateurs est soutenu par des méthodes peu fiables (Mori et al., 2010; Bramley, 2009).

Comme décrit ci-dessus, la littérature présente des études importantes qui fournissent des informations de base utiles et des ensembles d'indicateurs potentiels à utiliser. Moussiouplos (2010) met l'accent pour la mise au point d'une approche méthodologique basée sur un système d'indicateurs avec des caractéristiques spécifiques pour évaluer la zone d'étude. Il est aussi convaincu qu'un grand nombre d'indicateurs fournissant des informations environnementales, sociales et économiques risque de faire perdre les relations entre eux et donc perdre les objectifs du projet.

Cependant, dans la littérature se trouvent de nombreuses listes d'indicateurs appartenant aux trois piliers du développement durable. La majorité de ces listes sont plus concentrées sur l'évaluation de la dimension environnementale plutôt que sur l'évaluation de la dimension sociale ou sur la dimension économique. Une méthode d'évaluation devrait utiliser un

nombre d'indicateurs qui permettent d'évaluer simultanément les trois dimensions. Les indicateurs doivent être sélectionnés en considérant les exigences du projet, de ses objectifs et des attentes locales. La méthode pour sélectionner les indicateurs peut être faite à travers la participation des acteurs impliqués dans le projet d'aménagement. C'est dans les premières phases de la prise de décision qui doit être rédigée la liste d'indicateurs et cette liste peut être modifiée si des changements surviennent pendant le processus d'évaluation du projet.

En résumé, une méthode efficace devrait prendre en considération des indicateurs locaux qui reflètent les interrelations entre les dimensions, améliorer la fiabilité et la comparabilité des indicateurs (Mori, 2012). En outre, une méthode fiable devrait garantir que l'ensemble d'indicateurs choisi a une acceptation sociale maximale, augmentant ainsi la possibilité qu'ils soient adoptés par les communautés locales. Enfin, la méthode devrait établir un ensemble d'indicateurs couvrant l'ensemble des champs thématiques du développement urbain durable.

CHAPITRE 2

DÉMARCHE MÉTHODOLOGIQUE

2.1 Principes généraux

La démarche méthodologique est basée sur le cycle de vie d'un projet de réaménagement et des acteurs responsables de leur réalisation. Ce positionnement est abordé en regard des modes d'utilisation des terrains vacants et de leur utilisation dans un contexte urbain et de la mise en valeur préconisé par les acteurs retenus, ainsi que par leurs propos et leurs objectifs et selon les attentes locales (Bramley & Power, 2009; Mori & Christodoulou, 2012; Moussiopoulos et al., 2010). À partir des positions de Kirkhou et Khartaus (2009) et des propos de Sharifi et Murayama (2013; 2015), ont été identifiés certains indicateurs d'intérêt pour le développement et la contextualisation des friches industrielles en nous concentrant sur les aspects socio-économiques. D'après Sharifi et Murayama (2016), une bonne méthode d'évaluation des projets urbains doit reposer sur des critères et des indicateurs qui sont les éléments de base de tout cadre de viabilité d'un projet. Comme le souligne Maclaren (1996), cité par Sharifi et Murayama (2013), les indicateurs utilisés pour l'évaluation de la durabilité doivent être bien intégrés dans le processus et pertinents, c'est-à-dire qu'ils doivent couvrir de multiples questions, être inter reliés et tournés vers l'avenir, assurer une répartition équitable entre les générations (équité intergénérationnelle), être élaborés avec la participation de multiples parties prenantes et tenir compte du contexte spécifique du site (l'équité procédurale) (Haughton et Hunter, 2003).

La méthode est principalement basée sur l'analyse des données des études de cas qui seront utilisées pour valider notre question de recherche (OG) en appliquant la stratégie proposée dans un contexte spécifique de la ville (*ex post*) et évaluer la contribution apportée avec notre proposition. La recherche s'inscrit dans le domaine des sciences appliquées dans les projets de réhabilitation urbaine et des systèmes d'aide à la décision. La méthode utilisée dans toutes les phases de cette recherche a été l'objet d'une évaluation continue (ou mieux d'études

transversales) afin d'en assurer sa rigueur dans le processus de conception et d'évaluation du projet.

2.1 Stratégie de recherche

Tel que présentée dans la section sur les principes généraux, la recherche est composée de deux axes principaux: 1) axe de recherche de type qualitative et 2) une recherche pratique (recherche empirique) basée sur deux études de cas. Il y a, aussi, d'autres sous-étapes pour identifier les critères d'application de la stratégie de recherche qui permettent d'interpréter les résultats.

La Figure 2.1 explique la démarche méthodologique. La démarche comprend quatre étapes principales : 1) Identification de la problématique à travers la revue de la littérature; 2) Caractérisation du problème à travers une étude de cas en intégrant des indicateurs sélectionnés à travers la littérature à la structure d'un outil d'évaluation reconnu; 3) Une étude de cas concernant l'existence de la problématique de recherche en appliquant une évaluation *ex post* à une friche industrielle réhabilitée; 4) Sélection à travers une étude qualitative du rôle des parties prenantes impliquées dans la prise de décision et des phases du cycle du projet, identification des indicateurs locaux et spatiaux pour aider les parties prenantes à l'évaluation du projet.

Comme montre la Fig. 2.1 dans chaque étape sont décrit aussi les outils utilisés pour chaque concept méthodologique. Les trois étapes centrales constituent le noyaux de la méthode, les flèches de chaque étape indique l'interaction entre elles.

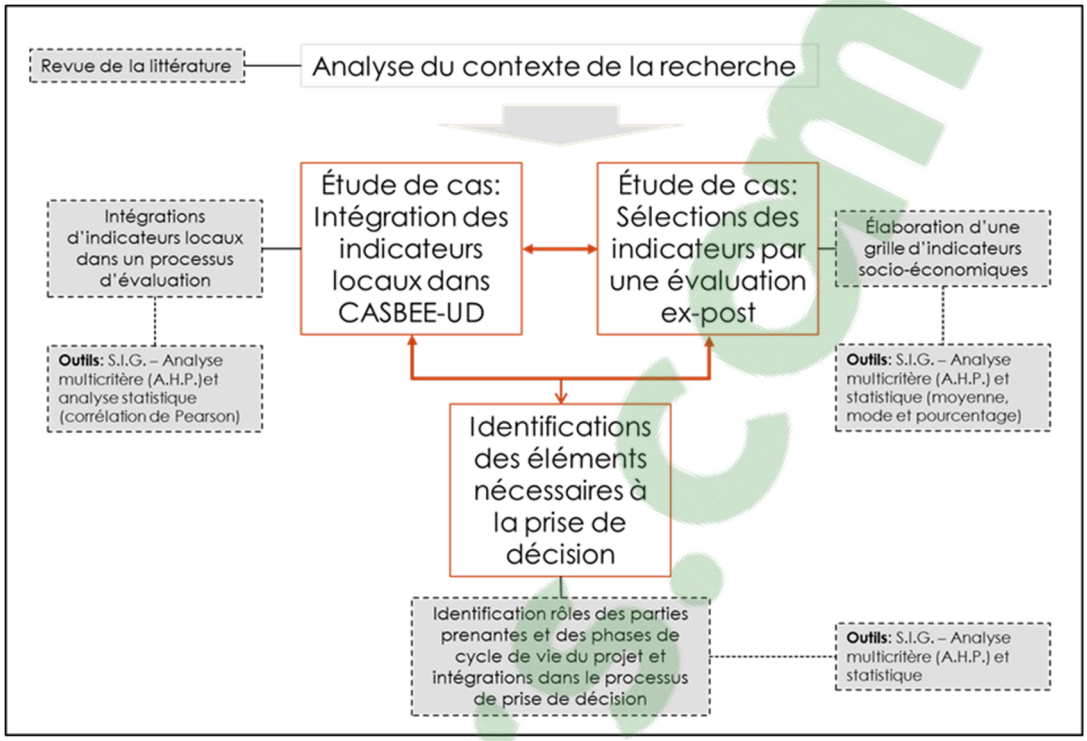

Figure 2-1 Démarche méthodologique

Première étape: Cette étape est composée de trois sous étapes principales 1) les choix des indicateurs socio-économiques; 2) l'intégration des indicateurs choisi dans une méthode d'évaluation existante et (3) la pertinence d'intégration à travers une étude de cas (méthode proposée) dans une méthode reconnue (CASBEE-UD) à un territoire défini. La première étape consiste aussi à choisir les indicateurs socio-économiques et à collecter les données associées à chaque indicateur, ce qui a permis de sélectionner les variables (dépendantes et indépendantes) avec lesquelles mesurer les indicateurs pour chaque dimension.

Deuxième étape : elle consiste en une revue des outils et des méthodes d'évaluations utilisées afin d'identifier les éléments fondamentaux qui permettront de caractériser la problématique. L'analyse repose sur l'identification de critères, de cibles et d'indicateurs. Les objectifs sont de proposer un ensemble de critères caractérisant les projets de réaménagement urbain et de procéder à l'identification des dimensions et des acteurs afin de sélectionner et de classer au mieux les indicateurs associés à chaque dimension.

Troisième étape : La caractérisation du problème s'appuie sur une étude de cas dans une friche industrielle partiellement réhabilitée à Montréal. La stratégie est basée sur l'utilisation d'indicateurs pour mesurer la performance d'un projet de revitalisation dans une friche industrielle. Le principal objectif de cette étape est d'observer les avantages et les inconvénients de la réhabilitation telles que des transformations des valeurs foncières causées par les interventions sur le cadre bâti existant et le phénomène de délocalisation des résidants. Cela donne la possibilité de démontrer si la réhabilitation de cette friche a contribué à améliorer la qualité de vie soit des milieux avoisinants soit de la friche réhabilitée. L'objectif est de réaliser une analyse ex post du projet afin de déterminer si les objectifs du projet ont été atteints.

Les données socio-économiques proviennent des quatre arrondissements de la ville de Montréal. Les variables sélectionnées proviennent de la littérature. De même, en utilisant les cartes des arrondissements et un Système d'information géographique (SIG), pour identifier les dimensions territoriales associées à la fonctionnalité de service. Une analyse multicritère hiérarchique (AHP) a été appliquée pour synthétiser les informations géographiques afin de sélectionner des données répondant aux préférences des citoyens. Ces informations incluent des critères basés sur les caractéristiques territoriales et la localisation des fonctions essentielles à la qualité de vie des citoyens. Les indicateurs socio-économiques ont été identifiés et pondérés à l'aide d'un outil d'aide à la décision basée sur l'analyse multicritère.

Quatrième étape : En utilisant les résultats obtenus avec les deux études de cas, a été élaboré la méthode d'évaluation. La méthode vise à identifier les phases essentielles d'un projet en général et de ne pas se limiter à un type de projet spécifique (renouvellement, développement nouveau, etc.). Les acteurs impliqués dans les projets de quartiers durables ont été identifiés et classés selon plusieurs critères (expertise, rôle, contribution). Les acteurs du projet ont été organisés en groupes afin de mettre en place une grille d'analyse et d'identifier des indicateurs environnementaux et socio-économiques dans chaque domaine thématique. Le travail a consisté à identifier les champs thématiques les plus représentatifs et à sélectionner les indicateurs environnementaux et socio-économiques. La méthode proposée soutient l'idée

que les projets (à différentes échelles), surtout dans la reconstitution urbaine, ne doivent pas être nécessairement un vecteur de redynamisation urbaine unidimensionnel, mais ils doivent s'appuyer sur le respect de l'environnement interne et externe au site (contextualisation du projet) et se baser sur les attentes de la communauté locale.

2.2 Collecte des données

Les données utilisées dans la première partie de la recherche ont été recueillies auprès de Statistiques Canada, du Portail Données ouvertes et auprès de la Ville de Montréal et de l'arrondissement de Sud-ouest. La collecte des données sur ces sites a commencé au début en novembre 2014 et s'est terminée en mai 2017. Elle a permis d'approfondir la problématique de la gestion de projets de réaménagement urbain et l'utilité d'avoir des systèmes d'aide à la décision. Les données observées auprès d'employées de la firme Provencher-Roy pour l'une des études de cas, plus particulièrement sur le volet des indicateurs socio-économiques et environnementaux. Ces données ont permis d'approfondir la recherche, de démontrer non seulement l'utilité de la participation et de la collaboration de toutes les parties prenantes, mais aussi la pertinence de la participation de la communauté locale afin de construire une multitude d'indicateurs locaux représentatifs aux attentes des habitants. Les données observées chez Provencher-Roy n'ont pas été utilisées à cause des problèmes pendant les consultations avec les citoyens et donc, le cabinet d'architecture n'a pas donné la possibilité de les utiliser, mais cela a été important pour comprendre comment les architectes choisissent leurs indicateurs pour l'évaluation du projet.

Compte tenu de ces objectifs, la sélection général des critères a été la suivant:

Stratégie d'enquête basée sur la sélection des indicateurs basés sur la revue de littérature: une sélection des thématiques à aborder basée sur un examen des études destinées à réduire le nombre d'indicateurs choisis, sous réserve des contraintes suivantes : 1) choisir les indicateurs les plus cités; 2) couvrir les composantes du développement durable et des

catégories prédéterminées pertinentes et 3) cibler les thématiques pour faciliter la collecte de données, la compréhension et la diffusion.

La figure 2.2 décrit le processus de sélection des indicateurs adapté du processus inspiré à Moussiopoulos et al., (2010) et qui a influencé le cheminement du choix des indicateurs locaux utilisés et proposés par notre démarche méthodologique. Ces indicateurs ont permis de construire un outil d'évaluation afin d'aider les parties prenantes dans le processus d'aide à la décision.

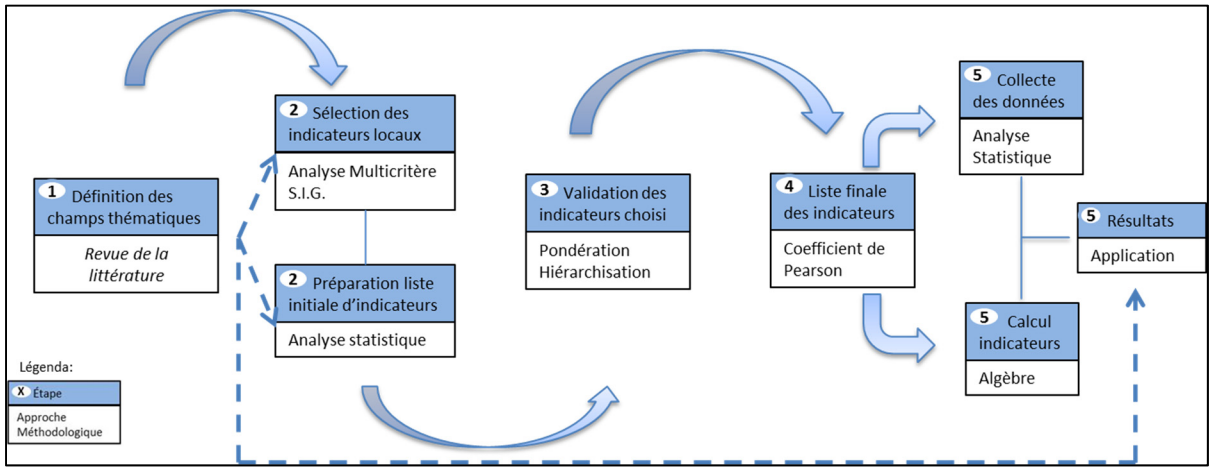

Figure 2-2 Processus de sélection des indicateurs
adaptée de Moussiopoulos et al. (2010)

Les données relatives à la deuxième étude de cas ont été obtenues auprès de la Ville de Montréal. Les données provenaient principalement de deux sites sur lesquels des méthodes mixtes de collecte de données ont été réalisées. Ces données et leur source sont reportée au CHAPITRE 3 et 5. Les études de cas et les méthodes mixtes sont de plus en plus populaires dans ce domaine de recherche car elles permettent une étude plus complète et plus rigoureuse des phénomènes étudiés dans leur contexte (Mori & Christodoulou, 2012) et fournissent également les bases nécessaires à la construction et à l'évaluation de ce genre de projet (AlQahtany, 2013). Aussi, en prenant en considération un projet de réhabilitation urbaine en cours de développement (redéveloppement de la friche industrielle Angus, ilot central, Rosemont (Montréal) a été considéré pour connaitre réellement les problèmes de participation entre les gestionnaires du projet, le cabinet d'architectes et les habitants. Cela a

donné la possibilité de confirmer certaines inquiétudes dans les processus du projet et aussi de comprendre la problématique liée à l'utilisation d'indicateurs pour évaluer le projet (CHAPITRE 5).

2.2.1 Étude de cas 1 : Le projet de réhabilitation du canal Lachine-Turcot-Petite Bourgogne

Cette première étude de cas portait sur le projet de réaménagement de la friche industrielle canal Lachine-Turcot-Petite Bourgogne, qui est en fait un projet de réhabilitation urbaine. Le projet consistait en: 1) la restauration des écluses (no.1 et 2) du Vieux-Port; 2) le réaménagement prévu de l'autoroute et du Quartier Bonaventure; 3) le réaménagement de Griffintown; 4) la création du parc linéaire du lieu historique national du Canal-de-Lachine; 5) la transformation éventuelle du site du centre de tri postal de Postes Canada; 6) la reconversion des bâtiments de la Redpath; 7) la restauration de l'écluse Saint-Gabriel (no.3) et la constitution du parc archéologique de la Pointe-des-Seigneurs; 8) le réaménagement du site de l'ancienne usine Stelco; 9) la mise en valeur du Vieux-Canal et le réaménagement du secteur de l'écluse de Lachine (no.5). Les commanditaires du projet comprenaient : Parcs Canada, la Ville de Montréal et plusieurs partenaires privés. Initialement, le projet a coûté plus de 120 millions de dollars. Les données recueillies dans cette étude de cas ont été principalement utilisées pour soutenir notre prémisse (sous forme de question) de recherche c'est-à-dire vérifier si les objectifs socio-économiques et territoriaux perdurent jusqu'à la fin du projet et reflètent les attentes des habitants. Cela a été fait à travers une évaluation *ex post* afin de s'assurer et d'évaluer les problématique d'utilisation d'indicateurs et du processus de la prise de décision.

Les objectifs initiaux du projet étaient les suivants : 1) Permettre aux résidents de l'arrondissement de s'installer dans la friche industrielle; 2) Améliorer le cadre bâti existant; 3) Conserver et revitaliser des édifices historiques et les reconvertir; 4) Construire des logements abordables et sociaux; 5) Améliorer la situation économique des quartiers avoisinants la friche industrielle; 6) Améliorer l'inclusion et la mixité sociale.

L'évaluation ex post appliquée à ce projet de réhabilitation urbaine a vérifié à travers les données statistiques recueillies du début du projet en 2016 les effets de l'aménagement opéré. Enfin, nous avons pu étudier l'impact de la gentrification causé par le projet de réaménagement et apprendre que les objectifs initiaux du projet ne sont pas tout à fait pris en considération jusqu'à la fin.

Les données qualitatives recueillies pour l'étude de ce site étaient basées sur des observations sur le terrain. Les données quantitatives collectées ont consisté en la documentation du projet (spécifications et objectifs du projet).

2.2.2 Étude de cas 2 : L'application de l'outil d'évaluation CASBEE-UD intégré avec des indicateurs locaux à quatre arrondissements de la ville de Montréal

Les données collectées sur ce site ont également été utilisées pour concevoir l'approche méthodologique pour pouvoir évaluer sa pertinence en faisant une comparaison avec un outil d'évaluation reconnu au niveau international (CASBEE-UD). L'étude s'est concentrée surtout sur les indicateurs utilisés par cet outil et, aussi, sur l'intégration d'autres indicateurs que ont été sélectionnés localement. Les données ont été collectées en se référant aux quatre sites : Lachine, Plateau Mont-Royal, Ahuntstic et Ville-Marie. Nous avons sélectionné des données qualitatives et quantitatives. Les données qualitatives ont été obtenu à partir des enquêtes qui ont été menées par chacun des quatre arrondissements auprès des habitants. Ces enquêtes ont permis de connaître la perception du bien-être dans leur région et pour chaque type de réponse nous avons associé des indicateurs qui pouvaient mesurer cette perception. Cela a été fait pour associer et intégrer des indicateurs locaux qui pourraient mieux évaluer le contexte local (cette étude de cas est décrite au CHAPITRE 3). La récolte des données a commencé à partir du mois d'avril 2016 jusqu'à la fin de novembre 2017.

2.3 Lien entre les objectifs spécifiques de la recherche et les articles

Trois articles ont été rédigés dont chacun répond à l'un des objectifs spécifiques de la question de recherche. Le Tableau 2.1 résume la démarche pour répondre aux objectifs spécifiques.

Tableau 2-1 Démarche utilisée pour atteindre les objectifs de recherche

Objectif général	Développer un outil de planification qui intègre des indicateurs socio-économiques pour réduire les impacts négatifs dans les interventions sur le cadre bâti tout en répondant aux attentes des utilisateurs		
Objectifs spécifiques	Évaluer la pertinence de l'intégration des indicateurs sélectionnés dans un processus d'évaluation de territoire	Élaborer une grille d'indicateurs socio-économiques dédiée à l'évaluation d'un projet de réhabilitation d'une friche industrielle;	Établir les rôles des parties prenantes à chaque étape du cycle d'un projet de réhabilitation;
Approche ou méthodologie utilisée	Analyse multicritère; S.I.G. Analyse statistique	Analyse multicritère (A.H.P.) Analyse statistique – coefficient de Pearson	Analyse données statistiques S.I.G.
Article répondant à chaque objectif	Chapitre 3 "The integration of socio-economic indicators in the CASBEE-UD evaluation system: a case study". Publié dans UrbanScience	Chapitre 4 "Socio-economic indicators for the ex-post evaluation of brownfield rehabilitation: a case study". Publié dans UrbanScience	Chapitre 5 "A methodological approach for evaluating brownfield redevelopment projects". Publié dans UrbanScience

Avec l'article 1 (CHAPITRE 3) nous avons expliqué que, dans les processus de réhabilitation des friches industrielles, il n'y a pas d'indicateurs socio-économiques adéquats pour atteindre les objectifs du projet selon les attentes de la communauté locale. L'article 1 a répondu au troisième objectif spécifique de la recherche. Dans cet article les indicateurs identifiés ont été intégré à un outil d'évaluation reconnu pour l'aide à la décision et d'après a été évalué l'effets de cette contribution par une étude de cas d'une friche industrielle à Montréal. Dans la section 6 « Discussion générale » une réflexion a été faite pour aborder les préjugés liés au projet et aux hypothèses personnelles et leur contribution. L'article 2 (CHAPITRE 4) a

répondu au premier objectif spécifique de la recherche. Dans cet article on a utilisé une évaluation ex post pour vérifier si les objectifs initiaux du projet ont été atteintes. Dans la section « Conclusions » a été décrit la démarche pour l'évaluation du projet avec des indicateurs locaux. L'article 3 (CHAPITRE 5) a répondu au deuxième objectif spécifique de la recherche. Dans l'article a été décrit le rôle des parties prenantes et proposé une approche méthodologique pour l'évaluation d'un projet de réhabilitation urbaine (friche industrielle).

2.4 Présentation de la contribution des articles de journal et de conférence

Cette section vise à la présentation des trois articles qui ont été publiée dans des revues scientifiques évaluées par des pairs. Les articles qui sont intégrés dans les chapitres suivent un fil conducteur répondant à notre prémisse (OG). Ils peuvent aussi être lus de façon autonome. Les articles 1 et 2 (CHAPITRE 3 et CHAPITRE 5) répondent à l'objectif général de la recherche ainsi qu'aux troisième et deuxième objectifs spécifiques.

Ils sont rédigés soit d'un point de vue théorique (analyse de la problématique), soit d'un point de vue pratique (utilisation de notre méthode d'évaluation lors d'une étude de cas). L'article 3 (CHAPITRE 4) aborde les trois objectifs spécifiques et contribue au développement de notre approche méthodologique. Il répond ainsi à l'objectif général (OG) de recherche.

Les deux articles de conférence qui sont présentés dans les annexes ont été écrits pour supporter davantage le sujet de recherche. Les annexes I et II présentent deux articles de conférence qui précèdent la rédaction des articles de journaux et qui abordent la problématique de recherche. Ils contribue aussi à développer les réponses aux objectifs spécifiques pour aider à développer l'approche méthodologique. Ils contribuent ainsi à formuler une réponse au troisième objectif spécifique et aussi à l'objectif général de recherche. Cette structure peut sembler théorique mais cela donne la possibilité de structurer notre cadre méthodologique en se basant sur les indicateurs locaux et sur la participation des parties prenantes.

2.4.1 Article 1 – L'intégration d'indicateurs socio-économiques dans l'outil d'évaluation CASBEE-UD : une étude de cas

Le premier article, qui est basé principalement sur la revue de la littérature, analyse les outils d'évaluation utilisés à l'échelle du quartier et dans l'évaluation de projet de réaménagement des friches industrielles. L'article propose une analyse approfondie non seulement au niveau de la structure des outils, mais aussi sur le nombre des points de chaque domaine du développement durable, c'est-à-dire environnementaux, sociaux et économiques. L'article se concentre sur l'outil d'évaluation japonais CASBEE-UD et l'évaluation de cet outil met en évidence les forces et les faiblesses afin d'intégrer dans CASBEE-UD (quartier) les aspects sociaux et économiques pour l'amélioration de l'évaluation du projet. Dans l'article, nous avons sélectionné des indicateurs socio-économiques provenant de la revue de la littérature et des indicateurs locaux choisis par les quatre arrondissements de la Ville de Montréal concernée par le projet. Cela a été effectué à l'aide d'un processus hiérarchique d'analyse multicritère (AHP) et d'un système d'intégration géographique (SIG). L'application de l'analyse multicritère a démontré que l'application de l'outil d'évaluation CASBEE-UD intégré aux aspects socio-économiques à quatre arrondissements de la Ville de Montréal permet de mesurer le succès en répondant aux objectifs du développement durable. Cette étude a été faite pour améliorer le processus de prise de décision et pour définir une approche innovante pour l'évaluation de projet. En effet, les résultats de ces analyses ont fait comprendre aux acteurs impliqués dans la prise de décision que des indicateurs locaux et la contextualisation du site améliorent le succès des projets.

Ce premier article contribue aussi à la pratique en proposant une approche méthodologique innovante et concourt à la pratique en élargissant l'application des outils pour la sélection des indicateurs et des résultats. L'article fournit une base pour mesurer et évaluer les résultats et leurs impacts sur la réhabilitation urbaine.

2.4.2 Article 2 – Des indicateurs socio-économiques pour une évaluation ex post d'une friche industrielle : une étude de cas

Le deuxième article a été basé sur une étude de cas effectuée dans la friche industrielle du canal Lachine-Turcot-Petite Bourgogne. Les indicateurs locaux ont été choisi afin de vérifier d'une part si les objectifs du projet de réaménagement ont été atteints et d'autre part si l'approche utilisée par les intervenants du projet a été capable d'évaluer selon les objectifs initiaux de la réhabilitation de la friche. L'évaluation du projet a été faite 14 ans après son réaménagement (évaluation *ex post*). À l'aide des indicateurs (revenu, loyer brut (moyen) et usage locatif et propriété des habitations), une analyse de l'approche utilisée pour revitaliser cette friche a été réalisée. Le but de cette évaluation *ex post* était de déterminer le niveau de performance du projet de réaménagement et d'évaluer ces objectifs. L'analyse a démontré les lacunes de cette approche et son incapacité à contextualiser le projet à la Ville. L'évaluation indique que il y a une absence de mixité sociale et il a été négligé la construction de logements abordables, donc les objectifs du projet n'ont pas répondu aux attentes locales.

Ce deuxième article contribue au domaine des connaissances en démontrant d'abord la nécessité d'une collaboration entre toutes les parties prenantes afin de permettre l'application d'une approche opérationnelle. À partir de cela, a été proposé de développer une méthode qui tient compte d'indicateurs locaux capables d'évaluer le projet dans toutes ses étapes. L'approche proposée est utilisée pour soutenir l'évaluation des impacts de transformation de la réhabilitation urbaine opérée. Cette approche originale est basée sur des études réalisées sur les approches et les outils d'évaluation existants. Elle propose également une ontologie des éléments nécessaires à une prise de décision efficace, ainsi que des indicateurs liés aux composantes environnementales et socio-économiques qui devraient être intégrées à cet outil d'évaluation. L'article 2 contribue à la pratique en décrivant les étapes de sélection des indicateurs et les étapes d'évaluation du projet.

2.4.3 Article 3 - Une approche méthodologique pour l'évaluation d'un projet de réhabilitation d'une friche industrielle

Le troisième article porte sur le rôle de parties prenantes engagées dans les politiques urbaines qui sont impliquées dans le processus de décisions stratégiques pour le développement de leur territoire. L'article présente une analyse critique des outils d'évaluation qui sont appliqués dans le domaine de la construction. Ce regard critique vise à améliorer l'investigation théorique des outils existants. En effet, les résultats de ces analyses ont permis de constater que ces outils étaient mal adaptés aux processus d'évaluation du projet. Même la structure des outils les plus couramment utilisés (LEED, CASBEE, BREEAM), est complexe et ne fournit pas les résultats requis pour les projets de réaménagement des friches industrielles. Leurs indicateurs ne sont pas équitablement répartis entre les trois dimensions du développement durable (environnemental, social et économique), ce qui ne reflète pas le contexte spécifique du projet et les attentes locales.

Cet article contribue au domaine des connaissances en appliquant une étude transversale et interdisciplinaire sur la durabilité et il examine entre autres les indicateurs locaux pouvant être utilisés dans les projets de friches industrielles. L'article met en évidence les implications d'une approche méthodologique dérivée de l'analyse des méthodes utilisées dans les projets de développement urbain. Il aborde également le concept de collaboration et examine les écarts entre la théorie et les pratiques de collaboration entre les parties prenantes. Il a pour objectif d'identifier et de classer les éléments nécessaires à la prise de décision, y compris les indicateurs liés aux composantes environnementales et socio-économiques, afin de développer un outil d'évaluation efficace. Le troisième article contribue à la pratique en posant les bases pour le développement d'un outil d'évaluation efficace.

2.4.4 Article de conférence 1 (Annexe I) – L'intégration des aspects environnementaux et socio-économiques dans un outil d'évaluation d'un projet de réaménagement urbain

L'article de conférence 1 introduit l'utilisation des outils d'évaluation et identifie les potentialités et les faiblesses de ces outils. Il expose la nécessité de la participation de toutes les parties prenantes dans les phases du projet et de l'utilisation des indicateurs qui doivent être équitablement répartis entre les trois dimensions du développement durable afin de refléter le contexte spécifique du projet et les attentes locales. Il discute aussi non seulement de l'interrelation entre ces dimensions, mais présente aussi un aperçu de l'utilisation de l'analyse multicritère pour aider les acteurs du projet dans le choix des indicateurs. Il propose également une interrelation entre le processus décisionnel et le contexte du projet et discute de cette interrelation dans les phases du développement du projet. Il développe un outil d'évaluation issu d'une analyse des méthodes utilisées dans les projets de développement urbain. Il offre aussi une étude transversale et interdisciplinaire sur la durabilité qui examine les indicateurs locaux pouvant être utilisés dans les projets de friches industrielles.

L'article de conférence 1 contribue au domaine des connaissances en offrant une vision plus large de l'interopérabilité entre les parties prenantes et les objectifs du projet nécessaires pour la construction des quartiers durables. Il contribue à la thèse en positionnant la participation des parties prenantes et de certains concepts qui lui sont associés, à savoir l'interopérabilité entre eux et la satisfaction de la communauté locale. Ce papier aborde les deux premiers objectifs spécifiques de la recherche (OS 1 et OS 2) et aide à formuler une réponse à l'objectif spécifique 3 (OS 3).

2.4.5 Article de conférence 2 (Annexe II) – Réduire les impacts de l'environnement bâti par l'intégration d'indicateurs socio-économiques locaux dans les outils d'évaluation

L'article de conférence 2 explore l'inclusion de la notion du « développement durable» dans le domaine de la construction et comment cela est à l'origine de nouvelles méthodologies pour améliorer le cadre bâti dans les friches industrielles.

Il présente une revue critique des outils d'évaluation les plus couramment utilisés pour répondre aux exigences des usagers. L'article met en évidence certaines faiblesses de ces outils d'évaluation. Par exemple la participation des habitants et des experts qui n'est pas prise en compte mais également le manque d'indicateurs liés aux aspects socio-économiques pour construire des quartiers plus « durables ».

L'article de conférence 2 contribue au domaine des connaissances en développant une série d'indicateurs locaux liés à la composante socio-économique. Il contribue aussi au domaine de la pratique en développant une approche méthodologique pour sélectionner les indicateurs. Ce dernier a été fait à l'aide d'un système d'information géographique (SIG) pour analyser l'environnement bâti existant et à l'aide de l'analyse multicritère pour établir les indicateurs les plus performants afin de les intégrer dans la norme CASBEE-UD.

Il couvre les deux premiers objectifs spécifiques de la recherche (OS 1 et OS 2) et contribue à formuler une réponse à l'objectif général de recherche (OG).

CHAPITRE 3

THE INTEGRATION OF SOCIO-ECONOMIC INDICATORS IN THE CASBEE-UD EVALUATION SYSTEM: A CASE STUDY

Francesco Cappai[a], Daniel Forgues[b], Mathias Glaus[c]

[a], [b] GRIDD-ÉTS – Département de génie de la Construction, École de Technologie Supérieure, 1100 Notre Dame W, Montréal (QC), Canada H3C 1K3
[c] STEPPE-ÉTS – Département de génie de la Construction École de Technologie Supérieure, 1100 Notre Dame W, Montréal (QC), Canada H3C 1K3

Article publié dans« Urban Science Journal » mars 2018

3.1 Abstract

The use of tools to measure the degree of sustainability of cities is the approach that receives the most attention in developed countries. However, studies of evaluation tools at the neighborhood level reveal that there are many weaknesses in the most widely-used evaluation systems (LEED-ND, BREEAM Communities, CASBEE-UD). There are ambiguities and gaps in weighting and in scoring and in most cases, there is no mechanism for local adaptability and participation. The purpose of this study is to provide an overview of the current situation by highlighting the strengths and weaknesses of these evaluation tools in order to integrate social and economic aspects for the improvement of the CASBEE-UD (neighborhood level) evaluation tool. The selection of socio-economic aspects was made through the use of multi criteria Analysis Hierarchical Process (AHP) and a Geographic Integration System (GIS). The results of this case study indicate that most evaluation tools need to be revised because most do not include socio-economic aspects. We have demonstrated that applying the CASBEE-UD assessment tool integrated with socio-economic aspects to four boroughs in the City of Montreal can measure success by addressing the objectives of sustainable development.

Keywords: neighborhood sustainability assessment; sustainability coverage; applicability

3.2 Introduction

The importance of the issue of sustainability in general and in particular of sustainable urban planning in communities, has emerged as one of the key issues for authorities and experts. In recent years, there have been various collaborations in the field of construction towards environmental objectives and sustainable development (Sharifi and Murayama, 2014). The construction sector has a major role in creating these changes at a huge cost in the consumption of non-renewable resources. According to data released by leading research institutes (World Commission on Environment and Development (WCED, 2014) and the European Environment Agency (EEA, 2009), the construction industry uses about 40% of the world's energy and 40% of its natural resources (raw materials and others) and produces 25% of the world's waste. Planners have recognized that the activities developed for the production and transformation of the built environment influence and determine the survival of natural systems. There is now a consensus on the importance and need to find strategies to mitigate these activities and to gradually increase the benefits of cities for their residents (Holden, 2013). These corrective strategies reinforce the development of new models to replace existing ones in order to reorient city transformation activities and techniques towards sustainability and to ensure that the expectations of the local community are respected (Wong, 2014; Kepaptsoglou et al., 2015). The core interests of the stakeholders in a building market are highly diverse, oftentimes conflicting and therefore their attitudes towards sustainable construction and an environmental labeling tool could vary significantly (Wong, 2014). In recent years, several collaborative initiatives in orienting construction activities towards environmental or sustainable development objectives have been established (Sharifi and Murayama, 2014). Several countries and institutions (United States, European Community, United Kingdom, Hong Kong (China), Japan, etc.) have developed new benchmarking methods for monitoring the sustainability status of their cities or neighborhoods. As a part of these initiatives, they have encouraged the utilization of tools to ensure that their cities strive for sustainability.

Evaluation systems are an example of policy tools that support the development of the "green" market. They also offer communities ways in which to become more sustainable, as well as to assess (and possibly improve) their level of sustainability.

Although there is a satisfactory amount of information on assessment tools at the neighborhood scale, relatively few studies have been conducted at this level (Kepaptsoglou et al., 2015; Kyrkou and Karthaus, 2011). It is therefore crucial that the scope of sustainability assessment systems shifts from the energy performance of individual buildings to the "broader" aspects of site-related urban assessment, as it is the cities/neighborhoods as a whole that have a more or less sustainable behavior (Szibbo, 2016). Jacobs (2010), supported by New Urbanism, says that "a sustainable way of life should effortlessly be derived from the way we design our sustainable neighborhoods, because green developments in neighborhoods benefit the community and the individual" (Kepaptsoglou et al., 2015; Kyrkou and Karthaus, 2011). In general, green neighborhood developments respect historical resources and the existing community fabric; they strive to preserve open spaces and encourage access to parks to maintain or improve the character of a neighborhood, including its streets, houses, workplaces, shops and public spaces. There is an implicit assumption in Jacobs' approach that these factors affecting urban life are somehow fixed and can be predetermined (Jacobs, 1961).

Three sets of certifications have been developed recently at the neighborhood level: LEED-ND (2014) developed by the Green Building Council in the US, BRE Global BREEAM Communities (2014) developed by the British Organization BRE Global and CASBEE-UD (2014) developed by the IBEC Institute for strengthening the Environment and Promoting Energy Conservation in Japan (Sharifi and Murayama, 2014; IBEC, 2014; BRE Global, 2015).

These tools were designed to assess the level of urban projects' sustainability in their cities, assessing sustainability first at the scale of the buildings and later at the neighborhood and city levels [8]. These evaluation systems are the three best-known and most-used but they

exhibit several weaknesses, especially on the socio-economic front (Sharifi and Murayama, 2015).

A common feature of all these evaluation tools is that they must be created by specific requests, coming from different actors or groups of actors or in response to particular contexts. Their reliance on being developed for unique situations results in two contradictory phenomena. On the one hand, there seems to be no universal method or tool that would be applicable and usable in any context, encompassing all the issues. On the other hand, they seem to be seeking a common measure for all. The search for guidelines intended to be global and valid for all, initiated by political demands that are often very general, results in directives that are not sufficiently operational. These directives give recommendations on themes but no orientation towards the devices or the paths leading to the development of concrete projects. In many cases, they require prior or even expert knowledge of users and so they are difficult to understand for most actors. This situation justifies the fact that the sustainable development approach will have to be interpreted locally, as each tool will have to adapt to a specific context.

In urban and neighborhood contexts, where different forces and entities influence the decision-making process, it is essential to add the social and economic aspects to sustainability assessment (Holden, 2013; Sev, 2011; Cities Alliance, 2007). In a study done in three areas of the United Kingdom, Turcu and Catalina (2013) found that the integration of socio-economic indicators with the traditional approaches to the evaluation of sustainability can better evaluate these areas in the urban context. They conclude that indicators are not isolated pieces of information but manifestations of underlying local processes and interconnections that can be mapped and that have the potential to broaden our understanding of local sustainability. Along the same lines, White and Lee (2009) used operational research to demonstrate that the integration of socio-economic indicators in a holistic approach improve urban sustainability.

3.3 Aim of the Study and Justifications for Using the CASBEE-UD Assessment Tool

The main aim of this study is the development of an appropriate methodological approach based on the integration of socio-economic aspects into the CASBEE-UD evaluation tool and its application in four boroughs of the city of Montreal. Using the multi-criteria Analytic Hierarchy Process (AHP), we determine the improvements made by the new tool by simultaneously applying the original CASBEE-UD and the new tool integrated with these indicators.

We selected this evaluation system based on the following four reasons: (1) There are no indicators in its structure with which to evaluate the social and economic dimensions and it does not include obligatory credits; (2) The CASBEE-UD includes a variety of tools for different phases of project development: planning, design, completion, operation and renovation. This structure is present at all levels of a city-wide building plan (Sharifi and Murayama, 2014; Sev, 2011). The CASBEE-UD not only considers the built environment but also all of the external environment; and (4) the whole evaluation process acquires a different character than that of other evaluation tools; it uses an additive/weighting approach that allows the addition of points obtained in all the performance areas (Sharifi and Murayama, 2014 - 2013; Sev, 2011).

This article is structured as follows: Section 2 presents a review of the relevant literature, Section 3 presents the methodology, which is followed by a presentation of the results in Section 4. These results are discussed in Section 5, along with the conclusions and recommendations for future work.

3.4 Scope of the Study

Urban neighborhoods, as defined by the users or participants are important spaces in which a local community can be given identity and secure a meaningful voice in assessing the sustainability of redevelopment processes and projects Cities Alliance, 2007; Cappuyns and

Kessen, 2012). However, at these places where many social and economic factors interact, the concept of neighborhood is ambiguous and in several cases its limits are never standardized (Jacobs, 1961). For example, Galster (2001) argues that the neighborhood could encompass four different zones, from the smallest block to the entire city sector. Galster, 2001 lists a number of attributes to help select neighborhood size, for example, the structural characteristics of non-residential buildings (size, building materials, housing density, the demographic composition of residents (age, race, class, family status), environmental characteristics (presence of water, greenery, degree of pollution), social-interactive aspects (number/type of neighbors, participation in local activities) and sentimental characteristics (identification with place, historical significance) (Galster, 2001). The main characteristic of integration of all these aspects is the neighborhood, which represents a spatially-limited area. However, its size depends on the way it is homogeneous and its dimensions. In this respect, Coulton et al. (2013) have indicated a number of measures to help planners to select a neighborhood's area. For example, a neighborhood can be selected by considering a homogeneous area in relation to structural aspects of housing (the type of buildings, their layout); this would be smaller than the homogeneous area determined by environmental features (e.g., pollution levels) but larger than the area where one interacts with neighbors or feels an attachment (Coulton, 2013).

In terms of the social and economic dimensions, a neighborhood is a place where many stakeholders have a role in decision making. The social dimension not only includes the interactions between the governmental and non-governmental organizations involved in decision-making but also a set of norms, laws and regulations that interact with one another. Spangenberg (2002), argues that this social dimension also has the potential to facilitate links between the other dimensions and thus to complement them. A neighborhood is a fundamental part of a city and a good starting point for creating a truly sustainable community. As mentioned by Choguill, (2008) the importance of neighborhoods as a front line in the battle for sustainability is highlighted by initiatives to pave the way for improving the contextualization of brownfields to the rest of a city. These initiatives make it possible to grasp tangible urban environmental issues that clearly exceed the size of a single building or

even a city block. The need for coordinated urbanization and mobility, the creation of multi-member dense clusters and the search for a better quality of urban life can be addressed through concrete solutions (Choguill, 2008; Luederitz, 2013).

It is in this perspective that the concept of the "sustainable neighborhood" has emerged, namely the realization of urban centers, dense and mixed, whose overall quality meets a thorough vision of sustainability. However, a number of parameters are needed to apply the concept of sustainable neighborhood (Burnett, 2007). As affirmed by Luederitz (2013), "in a sustainable neighborhood, we must respect the principles of sustainable neighborhood and take into account the mitigation of the impact on the less fortunate." This is in the concept of sustainable neighborhood that we need to take into account in the current situation. It seems obvious, as Katukiza and McFarlane (2011) suggest, that basic needs must be taken into account. According to the United Nations report of 2011 (WCED, 2014), more than one third of the urban population of the developing world lives in informal settlements. This issue must be a fundamental element of a set of principles for the sustainable development of urban neighborhoods.

3.5 Evolution of the Evaluation Systems

The central objective of most assessment tools is to act as a decision support tool (Blanch, 2010). They are mainly used to guide stakeholders towards goals that meet the expectations of the local community (Burnett, 2007). All of these approaches use indicators as criteria to generate relevant information. To a large extent the effectiveness of a sustainability assessment depends on the robustness and rigor of the evaluation method. A research framework consisting of indicators based on irrelevant or poorly-defined criteria can misinform and mislead policymakers (Sharifi and Murayama, 2014; De Sousa, 2006; Shen, 2012). Despite the relatively short history of these tools, the evaluation of neighborhood sustainability (NSA = Neighborhood Sustainability Assessment) has received considerable attention from the scientific community. To date, most studies have focused on the theoretical and unrealistic aspects (Sharifi and Murayama, 2014; Blanch, 2010; Shen, 2012).

The CASBEE evaluation system was developed in 2004 by the Japan Sustainable Consortium (JSBC) and involved committees in the academic, industrial and governmental sectors. The CASBEE family covers the scales of both buildings and neighborhoods. It is an independent assessment tool developed to help improve sustainability in town planning. CASBEE-UD not only uses building concepts, it also uses concepts related to the external environment of the entire site. The interior of the buildings is excluded. However, the family of products includes CASBEE "CASBEE urban area + Buildings," which allows the use of CASBEE-UD with assessment at the building scale (including interiors) (IBEC, 2014; Bramley and Power, 2009).

BREEAM, launched in 1990, was the first BEA tool in the world (Prior et al., 2001 cited by USGBC, 2014) and is the most widely used tool for assessing the environmental performance of buildings in the UK. It has been increasingly accepted in the sector as offering practice in environmental design and management (Shen, 2012). It was launched as a credit award system for new office buildings and today it offers various tools to assess different types of buildings (Table 3.1). BREEAM was developed to reduce environmental impact, ensure the best environmental practices in design, operation and management and to increase awareness of the impacts of buildings on the environment. Versions of its tools are continuously evolving. LEED was established in 1998 by the United States Green Building Council (USGBC) through a consensus process involving many stakeholders, with the objective of transforming the market for green buildings (Zimmerman and Kibert, 2007—cited by Sharifi and Murayama, 2014). Design team members can track their progress towards earning a LEED rating throughout the course of a project, without the need for special consultants. The LEED system is well-grounded in science and relates to the market in which it operates (Table 3.1). LEED can now assess eight different types of buildings. A new version for New Constructions was launched in April 2009: LEED v. 4 (USGBC 2014). Other evaluation methods are used in some other countries, some of which have also been used outside their native country. The two best known are SBTool (International) and Green Star (Australia). SBTool is the software implementation of the Sustainable Building Challenge (SBC)

assessment method that has been under development as the Green Building Challenge process since 1996 by a group of 14 countries. The unique feature of SBTool is that it was designed from the outset to reflect the different priorities, technologies, building traditions and cultural values of different regions and countries (Gu et al., 2006, IISBE 2007 cited by WCED, 2014). Green Star (Australia) was launched in 2003 by the Green Building Council of Australia (GBCA). Developed to establish a common rating tool with which to measure the environmental consciousness and awareness in the green building design and construction industry, as with BREEAM, GBCA focuses on a building's life-cycle impacts. Rating tools are under development for a range of building types and phases (LEED-ND 2017) (Table 3.1). All evaluation tools seek to measure the degree of sustainability of cities or of parts of them, as well as the degree of sustainability performance of each project. The assessment themes, criteria and indicators used by evaluation systems are not common to urban assessment tools, however. We therefore offer a brief description of what is meant by terms like "theme," "criterion," and "indicator," as these are the main subjects of concern for sustainability. Each theme contains one or more criteria that are "parameters used to assess the contribution of a project to achieve the required objective" (Sharifi and Murayama, 2014). Each criterion, in turn, has one or more indicators that are variables providing accurate measurements. This can be better explained by an example: "Resources and the environment is one of the main themes that includes "energy" as a criterion that can be measured by indicators" (Shen, 2012). Each evaluation tool presents a theme and for each theme there is a defined number of criteria. Each criterion is assigned a weight according to the relative importance it has within the sum of the criteria.

These are percentages of the total number of indicators, regardless of the number of points awarded to each of them after the application of the weighting factor. Considering the CASBEE-UD, the weighting coefficients applied to the criteria and the percentage of maximum points available for the themes are different from those of LEED and BREEAM.

Tableau 3-1 Breakdown of evaluation tool credit categories

LEED-ND [a]	**CASBEE-UD [b]**	**BREEAM [c] Communities**
Smart Location and Linkage	Resources and Environment	Governance
9 Criteria	19 Criteria	4 Criteria
Total points 28	Total points 41	Total points 8
Prerequisites no. 5	Prerequisites no. 0	All Mandatory Criteria
Neighborhood Pattern & Design	Social	Social and Economic
15 Criteria	6 Criteria	17 Criteria
Total points 41 points	Total points 6	Total points 47
Prerequisites no. 3	Prerequisites no. 0	All Mandatory Criteria
Green Infrastructure & Buildings	Location and Pattern and Design	Resources and Energy
17 Criteria	22 Criteria	7 Criteria
Total points 31	Total points 43	Total points 31
Prerequisites no. 4	Prerequisites no. 0	All Mandatory Criteria
Innovation & Design Process	Transportation and Mobility	Land Use and Ecology
6 Criteria	3 Criteria	6 Criteria
Total points 6	Total points 10	Total points 18
Prerequisites no. 0	Prerequisites no. 0	All Mandatory Criteria
Regional Priority Credits	Innovation and Economic	Transport and Movement
3 Criteria	0 Criteria	6 Criteria
Total points 4		Total points 15
Prerequisites no. 0		All Mandatory Criteria

a = U.S.; b = Japan; c = England

A study of the criteria used by LEED-ND, CASBEE-UD and BREEAM Communities, conducted by Sharifi and Murayama (2014) (Sharifi and Murayama, 2014; Blanch, 2010), showed that the distribution of the criteria and the allocation of the points that each theme

receives is different for each tool and that CASBEE-UD has fewer social aspects than the other two tools." All three evaluation tools considered are based on the principles of intelligent growth and include related criteria on development in the filling and redevelopment of brownfields (Table 3.1).

3.6 Weaknesses of these Evaluation Systems

The literature demonstrates that these tools need to be refined. The most significant weaknesses found with these evaluation tools or systems are: (1) Sustainability Coverage; (2) Inclusion of Prerequisites; (3) Adaptation to the Setting (Location); (4) Participation of Stakeholders and Citizens; (5) Placement of the Actors in the Project Phases; (6) Presentation of Results; and (7) Application of the evaluation tool to Different Contexts (EEA, 2014; Sharifi and Murayama, 2013; De Sousa, 2006; Shen, 2012).

For sustainability coverage, developers can use a more sustainable approach while improving the resilience of neighborhoods by contributing to a strong local economy that is (relatively) autonomous and has good infrastructure (Shen, 2012; Brandt & Svendsen, 2013). These aspects—local economy and good infrastructure—are highlighted in a study on the relationship between urbanization and sustainable urbanization, led by Brandt and Svendsen (2013). They are particularly important when addressing affordable housing needs to support inclusive communities. The health of local social networks, mixed-use neighborhoods and the local economy are key indicators of the ability of an area to adapt to various social and economic changes (e.g., gentrification) regardless of their inhabitants. In one of the few studies on the subject, Saynajoki (2012) found that some of the indicators used in NSA tools are not very relevant for assessing a community's health.

None of these tools has a mechanism for assessing the performance of governmental and non-governmental institutions in a neighborhood. In addition, other key criteria such as governance, decentralization, legal frameworks and instruments, information systems, research and education to institutionalize sustainable development are neglected. As these

tools evolve, institutional sustainability criteria are expected to be included in sustainability lists to address the issue of governance and the need for more efficient administrative procedures (Alnaser, 2008). All of these dimensions should be taken into account for sustainable development (Valentin and Spangenberg, 2000 cited by Sharifi and Murayama, 2013). The evaluation of sustainability is considered the latest generation of impact assessment tools and can be defined as "a process that directs decision making towards sustainability" (Sharifi and Murayama, 2013).

Therefore, context-specific criteria should be included in sustainability assessment, as well as the appropriate weights to be assigned to the values of the relevant specific communities. Unlike BREEAM and LEED, CASBEE uses a complex scoring and weighting system to balance value-addressing issues with the number of measures available (Sharifi and Murayama, 2013). This scoring and weighting is done using a mixture of qualitative and quantitative measures (Blanch, 2010; Sharifi and Murayama, 2013). These weightings are more complex than those of LEED, BREEAM, or Green Star and make it impossible to work on the value of each indicator until the final score has been determined. The weighting coefficients are determined by questionnaire surveys of the various users of the tool, such as designers, owners, operators and related officials. The weighting coefficients can be modified to suit local conditions such as climate, as well as to reflect local priorities and policies (IBEC 2010). Each criterion is composed of 5 levels, scored between 1 (lowest) and 5 (highest). However, this structure does not give the possibility to differentiate the points available, because the pointing levels 1 and 5 are always the only designated points. In many cases, because of this problem, one or more levels are designated as inapplicable without giving a reason (Sharifi and Murayama, 2013). This could impose an additional economic burden on the developer but it is the only way to ensure the viability and reliability of the assessment results (Sharifi and Murayama, 2013).

In terms of adaptation to the location, evaluation systems should be adaptable to the type of development and to any specific questions relevant to the site (Sharifi andMurayama, 2014). For example, Cappuyns and Kessen (2012) examined the relevance of using the LEED-ND

assessment tool at the neighborhood level in England and in Germany. BREEAM Communities has been used in several countries in the European Community. The CASBEE-UD has been used almost exclusively within Japan and only by some Japanese cities. The Japanese government has now imposed this evaluation tool for all major projects. We found that the only country that has used CASBEE-UD in Europe is Spain, in a project to revitalize a neighborhood in Barcelona (Universitat Politècnica de Catalunya). Other criticisms are the lack of citizen participation in proposing a project, because they are written exclusively by experts (Shen, 2012). The importance of the participation of different political and academic actors and of the community during the various stages of planning is widely recognized (Khakee, 1998 cited by Sharifi and Murayama, 2014). By focusing on the inseparability of planning and evaluation, this perspective suggests that the evaluation should be a discussion among all the actors who are somehow affected by the assessment and should take the form of negotiations rather than pursuing a solution to a problem (Shen, 2012). Finally, citizens can participate by providing feedback that planners can use for system updates (Haapio, 2012). As for the use of such assessments, planners and developers can decide which changes are needed to bring about the desired economic development in alignment with environmental limits and social needs. The evaluation results can potentially be used by different stakeholders, including planners, designers, local authorities, real estate developers and residents. A sustainability assessment must provide an adequate and reliable picture of the situation in the field. It has the potential to guide decisions for planning, to guide the evaluation of actions and assess the degree of progress towards sustainable development as well as to educate residents (Sharifi and Murayama, 2015). The assessment report should be simple and transparent and must provide an adequate and reliable snapshot of the situation on the ground to avoid any unfounded decisions.

The results should be analyzed to assess their ability to meet specified goals. BREEAM Communities and LEED-ND have a similar way of presenting their final assessment. The only difference between them is that in BREEAM Communities, projects that fail to acquire minimal thresholds are labelled accordingly. In most cases, certified projects receive a label based on the rankings they have achieved. CASBEE-UD, meanwhile, to some extent

addresses the deficiencies identified by presenting the results of each theme. In addition, it offers scales (weak, good, very good, excellent) that can be used to highlight certain performances (Blanch, 2010; Shen, 2012). Although the tools are tailored to the priorities and conditions of their respective countries, differences in climate parameters, in social and economic conditions and in types of developments are essential to make evaluation tools customizable Bramley and Power, 2009; Mori & Christodoulou, 2012). However, this may not be possible due to various constraints. In such situations, the adopted evaluation tool should be adapted and customized using the benchmarks and appropriate weightings as part of the assessment (Chrysochoou et al., 2018). When there are significant differences in scope, planners should be aware that one size does not fit all. A more personalized and customized tool with additional information may be required.

3.7 Research Design

The proposed methodological approach consists of three steps (Figure 3.1)

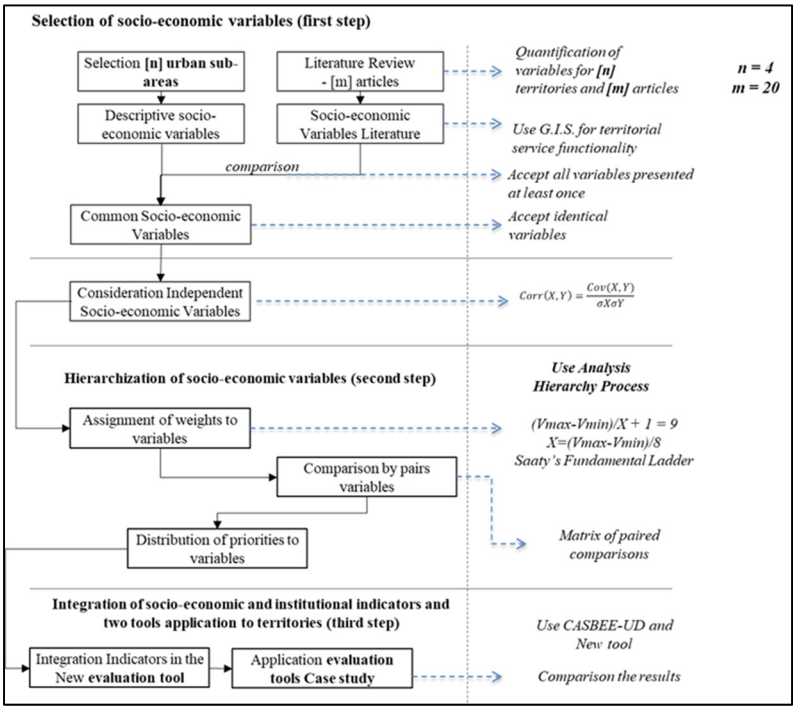

Figure 3-1 Methodological approach

In Step 1, two lists of socio-economic variables are established: variables from the data from the four selected boroughs (as detailed in Section 4), identified using statistical analysis and variables selected by reviewing the literature. Similarly, using district maps and the GIS, the territorial dimensions associated with the service functionality were identified. The GIS is composed of different layers of geographic reference information and is a technology applied to view and analyze data from a geographic perspective (ESRI), allowing the desired information to be viewed on a map. An AHP model was applied to synthesize the geographic information to select data to meet priorities that would satisfy citizens' preferences. This information includes criteria that are based on territorial characteristics and the location of functions essential for citizens' quality of life. This approach is a way to represent the true diversity and distribution of the services within a territory.

Socio-economic indicators were identified by means of a tool for decision support based on a multi-criteria AHP (Saaty, 1996). The AHP makes it possible to determine the cost-benefit ratio of a project, including the less-tangible advantages and disadvantages of its implementation. Using the AHP, we applied an equation to weigh, prioritize and integrate our criteria into the CASBEE-UD certification system. This phase offers the possibility of assigning points and dividing them into the three selected dimensions. Next, the Pearson's Correlation Coefficient (equation 4) was computed, putting one indicator next to another, as shown below.

$$Corr\ (X,Y) = \frac{Cov\ (X,Y)}{\sigma X \sigma Y} \tag{4}$$

where *Cov (X, Y)* denotes the covariance of the variables X and Y, and σX and σY denote the standard deviations. These results offered minimum values that eventually allowed us to remove some indicators from the final list (-0.5/0.0 and 0.0/0.5). We then accepted all of the strongly correlated variables between -1/-0.5 and 0.5/1.0.

Step 2 is where we prioritize the socio-economic indicators using the multi-criteria analytic hierarchy process (AHP). The variables were first calculated and then standardized, using Equation (5 and 6), before being used in the hierarchical analysis process.

Equation for Standardization Criteria:

$$\frac{(Vmax - Vmin)}{X} + 1 = 9 \quad (1)$$

$$X = \frac{(Vmax - Vmin)}{8} \quad (2)$$

where X is the scaling factor for converting a set of numbers with a maximum attainable value and a minimum attainable value of *Vmax* and *Vmin*, respectively, to express the comparison of pairs of two generic numbers of a set on a scale between 1 (indifference) and 9 (maximum prevalence). The difference between the maximum (*Vmax*) and the minimum (*Vmin*) values denotes the highest prevalence, so it must be equal to 9. In other words, (*Vmax* - *Vmin*)/*X* + 1 = 9. Thus, the pairwise comparison between Vi and Vj, with Vi greater than or equal to Vj, is equal to (*Vi* - *Vj*)/X - 1, with *X* = (*Vmax* - *Vmin*)/8; if *Vi* = *Vj*, then (*Vmax* - *Vmin)/X* + 1 = 1. This is a scaling factor *X* that scales the numbers of a set to express the pairwise comparison according to Saaty's semantic scale, which ranges from 1 to 9. In our case, (*Vmax*) was the maximum cited value of the total number of criteria and (*Vmin*) was the minimum cited value of the total number of criteria.

Step 3 has two parts. The socio-economic indicators found in the second stage are included in the CASBEE-UD in the first part and then both tools, CASBEE-UD and CASBEE-UD with the new indicators of the selected territory are applied. The new results were then compared.

To integrate the indicators in the CASBEE-UD evaluation tool, we first chose to integrate only those indicators associated with economic and social dimensions. After choosing our

indicators, a number of performance indicators were defined based on the objectives of the territories and values selected in the first step.

We propose that this type of approach leads to innovative solutions, both through the application of technological developments and by redefining the governance process. This creative dimension is integral to the philosophy of this type of project. It also has proven to be a successful factor in the implementation of an increasing number of sustainability criteria.

3.8 The Analytic Hierarchy Process (AHP)

The AHP approach is divided into four stages (Saaty, 1996): prioritization of the indicators by importance, constructing a matrix based on the pair-wise comparison of those indicators, determination of the weights associated with each indicator using an eigenvector calculation method and finally checking the consistency of the results.

3.8.1 Prioritization of Indicators by Importance

This step establishes the priorities between indicators belonging to the same criterion, according to the principle of importance. Let [I_1, I_2, ..., I_i ..., I_n] be the set of indicators whose weighting coefficient is sought. According to the principle of prioritization, [I_1] is more important than [I_2] which is more important than [I_{i-1}] which is more important than [I_i]. At the end, [I_n] is the least important indicator.

3.8.2 Comparison of Indicators by Importance

To establish preferences, a scale of values must be chosen to specify the degree of importance of one indicator over another. We adopt the value scale of 1 to 9 (Saaty, 1996), making it possible to introduce the decision-maker's judgments in a closer approximation to

reality. The comparison between all the indicators gives the following matrix and Equation (3):

$$A = \begin{bmatrix} a_{11} & a_{12} \cdots & a_{1n} \\ a_{21} & a_{22} \cdots & a_{2n} \\ a_{n1} & a_{n2} \cdots & a_{nn} \end{bmatrix}$$

$$a_{ij} = \frac{W_i}{W_j} \; and \; a_{ii} = 1 \tag{3}$$

where $[a_{ij}]$ is the intensity of the importance of $[I_i]$ on $[I_j]$ and $[W_i]$ is the weighting coefficient associated with $[I_i]$.

3.8.3 Determining the Weights Associated with Each Indicator

In this step, we calculate the vector of the weighting coefficients $W = \{w_1 \ldots w_2 \ldots w_n\}$. We divide each $[a_{ij}]$ by the sum of the values of the corresponding column and then calculate an average per line. Each coefficient $[w_i]$ is then obtained by Equation (4). The sum of the $[w_i]$ values must be equal to 1:

$$w_i = \frac{\sum_{i-1}^{n} [a_{i1/\sum_{k-1}^{n} a_{k1}}]}{n} \tag{4}$$

where $[a_{il}]$ is the intensity of the importance, $[a_{kl}]$ is sum of the values of the corresponding column and [n] represents the total number of coefficients.

Assigning weightings to the variables begins with using the Saaty scale to standardize the variables and then integrating them in the pairwise comparison matrix. The weights of the indicators are determined by the values of the calculated indicators. For example, for the criterion “accessibility,” the weights of the indicators are calculated by Equation (4).

3.8.4 Verification of the Consistency of the Result

A great advantage of the AHP is that it calculates a coherence index, which in turn makes it possible to evaluate the calculations made. In other words, it allows to verify if the scale

values (1–9) assigned by the decision maker are coherent or not. It also provides a measure of the probability that the matrix was completed purely at random. For example, if the consistency ratio (*CR*) equals 0.20, this means that there is a 20% chance that the decision maker has answered the questions in a purely random way. We define the vectors:

$[\lambda_1 \ldots \lambda_i \ldots \lambda_n]$ and $[\lambda'_1 \ldots \lambda'i \ldots \lambda'_n]$ by Equations (5) and (6)

$$\begin{bmatrix} \lambda'_1 \\ \cdots \\ \lambda'_i \\ \cdots \\ \lambda'_n \end{bmatrix} = \sum_{k-1}^{n} \left[w_k \times \begin{bmatrix} a_{1k} \\ \cdots \\ a_{ik} \\ \cdots \\ a_{nk} \end{bmatrix} \right] \left[w_i \times \begin{bmatrix} a_{11} \\ \cdots \\ a_{1i} \\ \cdots \\ a_{1n} \end{bmatrix} + \cdots + w_i \times \begin{bmatrix} a_{1i} \\ \cdots \\ a_{ii} \\ \cdots \\ a_{ni} \end{bmatrix} + \cdots + w_n \begin{bmatrix} a_{1n} \\ \cdots \\ a_{in} \\ \cdots \\ a_{nn} \end{bmatrix} \right] \quad (5)$$

$$\lambda_i = \frac{\lambda'_i}{w_i} \ \ then\ we\ get\ \ \lambda_{max} = \left[\sum_{i-1}^{n} \lambda_i \right] /n \quad (6)$$

The consistency index (CI) is then: $\frac{(\lambda max - n)}{(n-1)}$

To compute the consistency ratio (*CR*), the consistency index is divided by the value of the Random Index (*RI*) depending on the number of indicators (or the matrix size) (*n*) given by Table 3.2:

Tableau 3-2 RI coefficient values

Matrix size (n)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
RI	0.0	0.0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.53	1.56	1.57	1.59

Weight assignment is considered acceptable if the *CR* is less than 0.1. If not, the procedure must be applied again.

3.8.5 Aggregation of Indicators

A complete aggregation of indicators was selected for this study. All of the performance indicators are combined in a mathematical formula to obtain a single value for each criterion. The linear addition method (also known as the weighted sum method) is used here, one of the most widely-used aggregation methods (Bouyssou et al., 2006; Sahely et al., 2005). It assigns a performance score to each [PI_i] indicator that will be multiplied by a weighting coefficient [w_i]. The sum over [n] indicators gives an aggregate performance result, expressed in an overall score according to Equation (7):

$$PC_j = \sum_{i-1}^{n} PI_{ji} \times w_i \tag{7}$$

where PC_j is the performance score for criterion C_j, PI_i is the performance score for indicator I_i of criterion C_j and w_i is the weighting coefficient for indicator I_i of criterion C_j.

The application of the AHP relies on the determination of the matched comparison matrix to determine the priority vector. The calculation of the value of each index of the matrix is determined by the ratio of the occurrence indicators.

3.9 Results

3.9.1 Study Context

The study area is comprised of four boroughs in the city of Montreal (Canada):

Ahuntsic-Cartierville, Plateau Mont-Royal, Southwest and Lachine (figure 3.2). These boroughs have different economic, environmental and urban characteristics. The respective governments of the boroughs selected for this case study have for the past 20 years been investing in significant urban changes (revitalization of industrial wastelands, enhancement of the existing built environment and new urban developments). The data includes social variables (residents, workers, students, accessibility, site security, historical components,

inclusion/integration levels, etc.) and economic indicators (vehicle ownership, incomes, job types, buildings, job diversification, etc.). The database comes from the 2016 official population census (Statistics Canada) and each borough's own data. Spatial data were obtained from Montreal's land use maps and street maps. Spatial data was also analyzed using GIS software. All data were prioritized with the use of AHP.

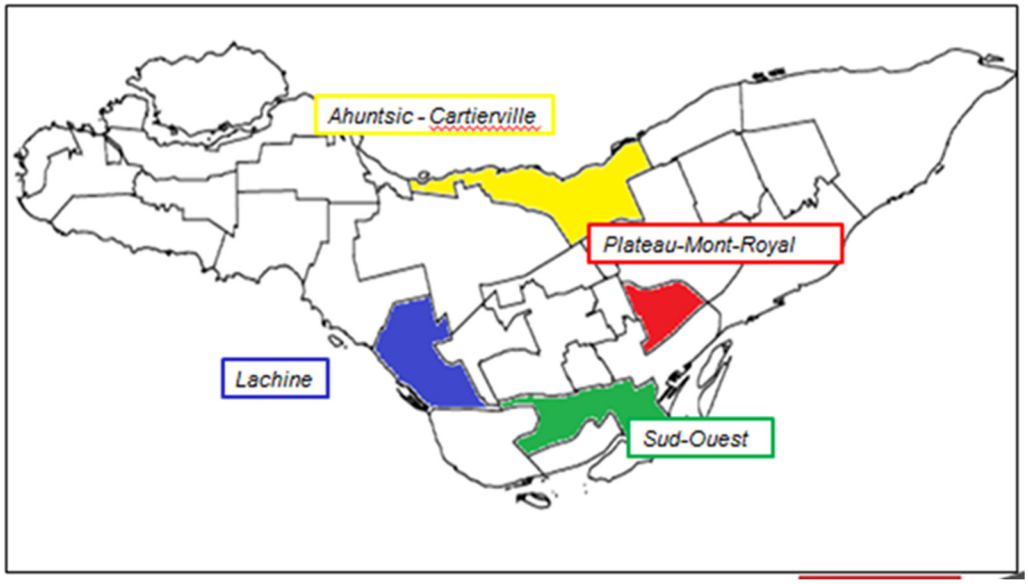

Figure 3-2 Boroughs being sampled

3.9.2 Step 1: Search for Independent Variables

In this step, we prepared data which shaped the variables and influencing factors that contribute to socio-economic aspects in each borough.

Definition and calculation of independent variables:

Population Density. Population is a source to provide thresholds for providing services and amenities. This variable does not indicate much by itself, but when used as a rate like density, it can be very helpful for imaging neighborhood conditions. A population map of official 2016 census data was prepared. This map overlays each borough in a GIS environment. Population density was calculated by dividing each neighborhood's population

by its area. This variable gives the average density of each neighborhood's population (Statistics Canada).

Green Pedestrian Margin. Green Pedestrian Margin helps to make a neighborhood attractive for pedestrians and cyclists, as well as for residents and workers. To calculate this variable, we first determined the area from an existing map (in hectare measurement) and then divided it by the total street kilometers to find the average value of streets per ha/km (City of Montreal).

Land Use Diversity. People generally select the closest facility in their locality. This selection preference covers the fact that some services like post offices mostly cover special areas. However, people may travel to other facilities due to differences in quality or uniqueness like cinemas, specialty shops and recreational facilities. In this study, we selected each service and other facilities with an area greater than 250 (m^2) and calculated the average distance from neighborhood homes to these services within a radius of 500 (m) and of 1000 (m) (City of Montreal existing maps).

Historical Activity. This aspect is based on the presence of traditional activities (for example cabinetmaker, glazier, shoemaker, framer, luthier). The variable is calculated from the total number of each type of historical activity, divided by the total number of jobs in each borough, thereby determining the percentage of each type of activity (Statistics Canada).

Government Inquiries. This variable is an indication of issues that are important to citizen and often controversial. These may include issues such as government structure, treatment of minorities, events of considerable public interest or economic issues. This variable indicates the number of inquiries made in each neighborhood (Borough's Government).

Housing Diversity. Based on the characteristics of housing construction in each borough, this variable makes it possible to determine the age of each house and the milestones that a borough has gone through in its policies of urban expansion. This variable is calculated from

each type of housing divided by the total number of residences. This variable thus indicates the percentage of each type of residence. (City of Montreal maps).

In the context of statistical analysis, we selected variables independent of socio-economic aspects. We extracted independent variables from 21 articles in the literature and from data of the four selected boroughs (Table 3.4). We selected any variables that were quoted at least once. Comparing the two lists of variables, we then selected 31 equivalent variables (Column 3—Table 3.4). After calculating the Pearson coefficient, a list of final variables was obtained (Column 4—Table 3.4).

Indeed, all of the selected variables have a correlation and influence the criteria used in the CASBEE-UD. For example, all of the variables related to transportation can be used to evaluate both active transportation and public transportation. However, we believe that transport must be evaluated as a whole, so that the tool will be able to be used in more situations. The other variables that we have chosen to integrate into the CABEE-UD are those that have a connection to the accessibility of the site. As shown in our analysis of the tools in the context section, we observed (see Table 3.1—Breakdown of evaluation tool Credit Categories) that in the CASBEE-UD only 3% of the points are related to this aspect. For example, variables such as street intersections and distance to services, which have a connection to neighborhood accessibility, show the effectiveness of supporting a sustainable neighborhood. Calculating the correlation coefficient between such variables and the road system reveals that this system has a strong correlation with street density, intersection density and mean batch density and negative correlation with the average block length.

The road system also indicates that it has a strong correlation with the proximity of a public transport station and a correlation with the green areas (Column 4—Table 3.3). Obviously, density is strongly correlated with the proportion of apartments and the diversity of the housing stock (Column 4—Table 3.3).

The most representative weighting scores for socio-economic variables are indicated in Table 3.4. For example, distance to the station, population density, public transport options and land use.

Other key variables are also included: the number of jobs, the number and type of activities in the neighborhoods and job diversity these variables have scores ranging from 0.962 to 0.856 and influence a neighborhood's sustainability assessment. The water surface variable appears to have less impact on a neighborhood assessment score, as its score is only 0.622. (Column 4—Table 3.3). Other variables that have a positive effect on the evaluation are those related to heritage conservation; cultural and historical environments have a score ranging from 0.8 to 0.531. As for the calculation of the correlation coefficient with respect to land use, the correlation of distance from the shopping areas is high at 0.883 and even more so for the local elementary school, 0.893, while the distance correlations with green space and with industry are slightly lower at 0.794 and 0.741, respectively (Column 4—Table 3.3).

As explained earlier, after the calculation of the Pearson coefficient, we chose to only use those variables that were highly correlated and thus only considered variables with a minimum score of 0.8. Table 3.4 contains the list of these selected variables.

Tableau 3-3 Independent variables of the Boroughs and from the Literature

A) Borough Variables	**Literature Variables**	**B) List of Selected Variables (unite of measure)**	**Pearson's Correlation Coefficient**
Street Density	Street Density	Street Density (m/ha)	0.790
Intersection Density	Intersection Density	Intersection Density (unit/ha)	0.736
Average Lots Density	Average Lots Density	Average Lots Density	0.686
Average block length	Average block length	Average length of de blocks	-0.636
House Diversity (affordable house)	House Diversity	House Diversity (Number of each Type of House)	0.616
Apartment's proportion	Apartment's proportion	Apartment' proportion (apartment/total house)	0.649
Number historical houses	Number historical houses	Number historical houses (hh/total house)	0.757
Pedestrian Marginal Green	Pedestrian Marginal Green	Green Pedestrian Margin (ha/street km)	0.964
Land Use Diversity	Land Use Diversity	Land Use Diversity	0.896
Public areas	Public areas (Parks, living areas)	Living areas (m^2)	0.805
Water surface	Water surface	Water surface (m^2)	0.622
Population density	Population density	Population density (person/ha)	0.953
Number of jobs	Number of jobs	Number of jobs (No Jobs)	0.962
Job Type	Job Type	Job Type (Number)	0.889
Total income	Total income	Total income ($)	0.856
Historical activities	Historical activities	Historical activity (No. H.A./Job type)	0.892
Politics inquiries	Politics inquiries	Government inquiries (Number)	0.531
Crimes	Crimes	Crimes (Number)	0.601
Public transportation	Public transportation	Public transportation (No. bus, metro and train)	0.899
Vehicle and Bike parking	Parking	All Public Parking (m^2)	0.730
Distances (airport, railway station, high school, mosque, Anglican and catholic church, primary, school, museum, health center, shop areas, green spaces, industry)	Distance all railway Station	Distance all railway Station (km)	0.962
	Distance to Green Space	Distance to Green Space (km)	0.794
	Distance to Industry	Distance to Industry (km)	0.741
	Distance to shop areas	Distance to shop areas (km)	0.883
	Distance to high school	Distance to high school (km)	-0.288
	Distance to mosque	Distance to mosque (km)	0.228
	Distance Anglican church	Distance Anglican church (km)	0.266
	Distance catholic church (km)	Distance catholic church (km)	0.222
	Distance to primary school	Distance to primary school (km)	0.893
	Distance to health center	Distance to health center (km)	0.368
	Distance to museum	Distance to museum (km)	0.749

Tableau 3.3 Independent variables of the Boroughs and from the Literature (suite)

A) **Borough Variables**	**Literature Variables**	**B)** **List of Selected Variables (unite of measure)**	**Pearson's Correlation Coefficient**
Bus frequency	Detached house's proportion	N/A	N/A
Street Connectivity	Semi-detached houses' proportion	N/A	N/A
Soil decontamination	Row houses' proportion	N/A	N/A
Heat island	Non-residential density	N/A	N/A
Trees of the plant cover	Diversity	N/A	N/A
Street trees	Waste management	N/A	N/A
Vehicular spaces vs pedestrian	Distribution of functions	N/A	N/A
Roof planning	Contiguity	N/A	N/A
Opening of the ground floor	Streets frame	N/A	N/A
Entrance doors	Ease of movement	N/A	N/A
Ground level ground floor	Traffic flow	N/A	N/A
Wooden content of the structures	Economic diversification	N/A	N/A
Recycled content of infrastructures	Location	N/A	N/A
Total annual energy consumption	Connection	N/A	N/A
Energy use index (EUI)	Partition areas	N/A	N/A
Air Conditioning (Cumulative Load)	Distribution of services	N/A	N/A
Heating	Inclusion	N/A	N/A
Lighting (Security)	Security	N/A	N/A
GHGs related to energy	Structure	N/A	N/A
Medium U - wall and fenestration	Technology	N/A	N/A
Compactness of buildings	Protection	N/A	N/A
Built Density - Raw COS	Care and maintenance	N/A	N/A
Natural lighting		N/A	N/A
Solar access		N/A	N/A
Presence of residents		N/A	N/A
Traffic		N/A	N/A
Urban form		N/A	N/A
Fragmentation		N/A	N/A
Type building		N/A	N/A
Religion		N/A	N/A

Tableau 3-4 Selected list after factor analysis of independent variables

Code	Variables	Calcul
Var1	Green Pedestrian Margin (ha/street km)	0.964
Var2	Land Use Diversity	0.896
Var3	Residential Areas (m^2)	0.805
Var4	Population Density (person/ha)	0.953
Var5	Number of Jobs	0.962
Var6	Job Type (Number)	0.889
Var7	Total Income ($)	0.856
Var8	Historical Activity (No. H.A./Job type)	0.892
Var9	Public Transportation (No. bus, metro and train)	0.899
Var10	Distance to Railway Station (km)	0.962
Var11	Distance to Shop Areas (km)	0.883
Var12	Distance to Elementary Schools (km)	0.893

3.9.3 Step 2: Hierarchization of Socio-Economic Variables

Having identified the final indicators of the socio-economic aspects, we apply the multi-criteria method (the AHP) to determine the weights for each dimension (criteria) and indicator (sub-criteria). This step is fundamental for the identification of the points for each dimension and to know the importance of each indicator in the alternatives (dimensions). The application of the AHP relies on the determination of the paired comparison matrix to determine the priority vector. The calculation of the value of each index of the matrix is determined by the ratio of the occurrences of the best indicators. For the calculation of priorities (indicators that need to be prioritized in order to understand their distribution in the CASBEE-UD), both with regard to the criteria and sub-criteria and with regard to the possible solutions, we used the average geometric method. The opinions expressed in the literature were examined and the criteria and sub-criteria for the two alternatives (CASBEE-UD and CASBEE-UD with integrated indicators) were added in order to construct a matrix of paired cumulative comparisons on which to apply the method. The geometric mean was then used to obtain the priority vector as presented in the methodology section. To calculate the weight of the criteria, we used the analysis conducted through the review of the literature and data from the four boroughs. Our approach differs from the conventional approach that usually relies on expert consultation to obtain their opinions and thereby determine the criteria prioritization. Instead, we identified the importance of criteria (prioritization) based

on their occurrence in the literature. The selected articles necessarily had to deal with the three dimensions of sustainable development (environmental, social and economic) in an urban planning context (brownfields, new developments, etc.). The results obtained from the 20 articles and the boroughs' statistical data were then placed in order of preference for each criterion. Then, utilizing the fact that each criterion based on its given position could obtain a maximum score of 24 (top of preferences) or 1 (bottom of preferences) we obtained the score indicators listed in Table 3.5.

For each variable initially selected, the process development was as follows:
(1) Determine the number of references in which the variable appears;
(2) Build the relationship matrix (Equation (3));
(3) Calculate the weight to be associated with each of the variables (Equation (4)).

This hierarchical classification allows us to proceed with the normalization of our variables. As described in the methodology section, this normalization was accomplished using the AHP method. We obtained the normalization presented in Table 3.7 by utilizing Equation (2).

The standardized variables were introduced into a matrix of paired criteria comparisons. Using the prioritization matrix, we obtained the weights of our indicators, thereby allowing us to divide them into their dimensions in order to integrate them into the new CASBEE-UD evaluation tool.

After calculating the weights of the variables with Equation (3) we determined the weight for each variable with Equation (4). The resulting weights of each variable are given in Table 5.8.

Tableau 3-5 Score Indicators

Criteria Ranking	**Assigned Number**
Var1	24
Var3	22
Var7	21
Var6	16
Var5	14
Var2	12
Var10	11
Var9	12
Var4	11
Var11	10
Var8	10
Var12	9

Tableau 3-6 Normalization and prioritization of territorial indicators (Analysis HierarchicalProcess (AHP))

Score	**OG**	**Var 1**	**Var 3**	**Var 7**	**Var 6**	**Var 5**	**Var 2**	**Var10**	**Var 9**	**Var 4**	**Var11**	**Var 8**	**Var12**
24	**Var1**	**1**	**1.20**	**0.32**	**2.11**	**1.07**	**0.84**	**0.34**	**2.66**	**1.89**	**1.86**	**2.55**	**4.50**
22	**Var3**		**1**	**0.91**	**0.93**	**0.16**	**0.39**	**0.89**	**1.48**	**0.70**	**0.68**	**1.36**	**3.32**
21	**Var7**			**1**	**1.82**	**0.77**	**0.55**	**0.05**	**2.36**	**1.59**	**1.57**	**2.25**	**4.20**
16	**Var6**				**1**	**1.07**	**1.30**	**1.80**	**0.57**	**0.25**	**0.27**	**0.45**	**2.41**
14	**Var5**					**1**	**0.25**	**0.75**	**1.61**	**0.84**	**0.82**	**1.50**	**3.45**
12	**Var2**						**1**	**0.52**	**1.84**	**1.07**	**1.05**	**1.73**	**3.68**
11	**Var10**							**1**	**2.34**	**1.57**	**1.55**	**2.23**	**4.18**
12	**Var9**								**1**	**0.80**	**0.82**	**0.14**	**1.86**
11	**Var4**									**1**	**0.05**	**0.68**	**2.64**
10	**Var11**										**1**	**0.70**	**2.66**
10	**Var8**											**1**	**1.98**
9	**Var12**												**1**

Tableau 3-7 Variables weights assigned AHP

Criteria Ranking	Assigned Weight
Var1	0.127
Var2	0.092
Var3	0.115
Var4	0.082
Var5	0.095
Var6	0.097
Var7	0.105
Var8	0.056
Var9	0.071
Var10	0.071
Var11	0.060
Var12	0.027

Tableau 3-8 Thematic fields and neighborhood setting in dimensions

	Thematic Field (Dimension)	Neighborhood Settings
Environmental Valuation	Natural Resource Management (Storm water, sewage, alternative energy, etc.); Biodiversity; Quality of Natural Areas	Infrastructure System Water, Water Consumption (including water quality); Energy consumption; Green Spaces; Water Surface; Vegetation;
	Environmental Protection (Floodplains, Rivers, Lakes, Wetland, Parks, Animals, etc.)	Use of Space; Living Areas; Landscape (Unnatural Barriers, Bridges, Viaducts); Enhancing Biodiversity; Morphology; River System
	Improved Comfort and Health (Pollution of the Site)	Ventilation; Physical comfort; Proportion of Own Sites; Soil Quality; Lighting
Equitable Social Value Social Responsibility	Strengthening Cohesion and Social Equity	Accessibility; Public Spaces; Density; Distribution Services; Inclusion; Security; Land Use Diversity; Population Density; Total Income
	Enhancement of the Architectural (Buildings and Material) and Historical (Preservation of Historical Memory) Heritage	Structure; Materials; Technology; Protection; Care and Maintenance; Form; Architectural Fragmentation; Architectural Quality; Residential Areas;
Economic Strategy	Cost Reduction	Waste Management; Distribution functions; Service-Business; Contiguity
	Increase of Cohesion (Accessibility and Transportation) and economic Dynamics (Employment and Business)	Streets Network; Public Transport; Fluidity of Movement; Parking; Links, Connections; Economic Diversification; Number of Jobs; Job Types; Public Transportation; Green Pedestrian Margin
	Multi-functionality of the territory, Territorial Competitiveness	Location; Connections; Partition Areas; Urban Form (Urban Fabric); Public Areas; Historical Activity; Distance to Railway Station; Distance to Shopping Areas; Distance to Primary Schools

The consistency of the results was verified by comparing them with the table of coefficient values (*RI*) and utilizing Equations (5) and (6). The consistency calculation makes it possible to determine if the weights assigned to each variable are considered acceptable according to the scale of the values' comparison.

Employing Equation (7) allowed us to obtain the performance values of all of the variables. At this point we added other variables that already exist in the structure of CASBEE-UD to our previously-selected variables. The aggregation of these variables then allowed us to assemble the thematic fields and neighborhood settings presented in Table 3.8.

Table 5.8 contains all the variables that we have taken into account, both the new variables and those that were already present in the structure of the CASBEE-UD. We integrate these new variables into the social dimension and the economic dimension. After the aggregation of all the variables we integrated them and applied both tools to the selected territory.

3.9.4 Step 3: Integration and Application of the Two Tools to the Territories

To determine the allocation of points for each dimension, for our new evaluation tool we assigned points that reflect local expectations that the areas to be improved are of roughly equal importance. Out of a 100-pt scale, we assigned 30 points for the environment and 30 for the social aspects and shared another 30 points for the economic aspects between 10 points for aspects strictly related to finance and employment and 20 points to account for the economics of the land use and the built environment, such as mixed use and compact development (Table 3.9). Transport was assigned the last 10 points and while we added indicators to evaluate all types of transport, it has the same number of points as established by the CASBEE-UD.

After applying the standard to the four city boroughs, we can observe the differences between the two assessment tools. As the charts in Figure 3.3 and 3.4 indicate, the tools evaluate each theme differently, according to the indicators contained in each tool.

Tableau 3-9 Integration indicators in the new tool and allocation of points for each dimension

Dimension	Criteria	CASBEE-UD	New CASBEE-UD
Resources and Environment	Energy, Materials, Biodiversity, Conservation, Resources, Water	41 points	30 points
Transportation	Public and Private	10 points	10 points
Social	Affordable Housing, Inclusive Communities Safety, Community Well-being Outreach, Heritage, Social Networks	6 points	30 points
Economic	Local Jobs, Finances, Investments, Employment, Business	0 points	10 points
Location		3 points	20 points
Pattern and Design	Mixed Use, Green Infrastructure, Compact Development, Access, Urban Planning and Design	40 points	
Innovation	Accredited Professionals Innovation	0 points	

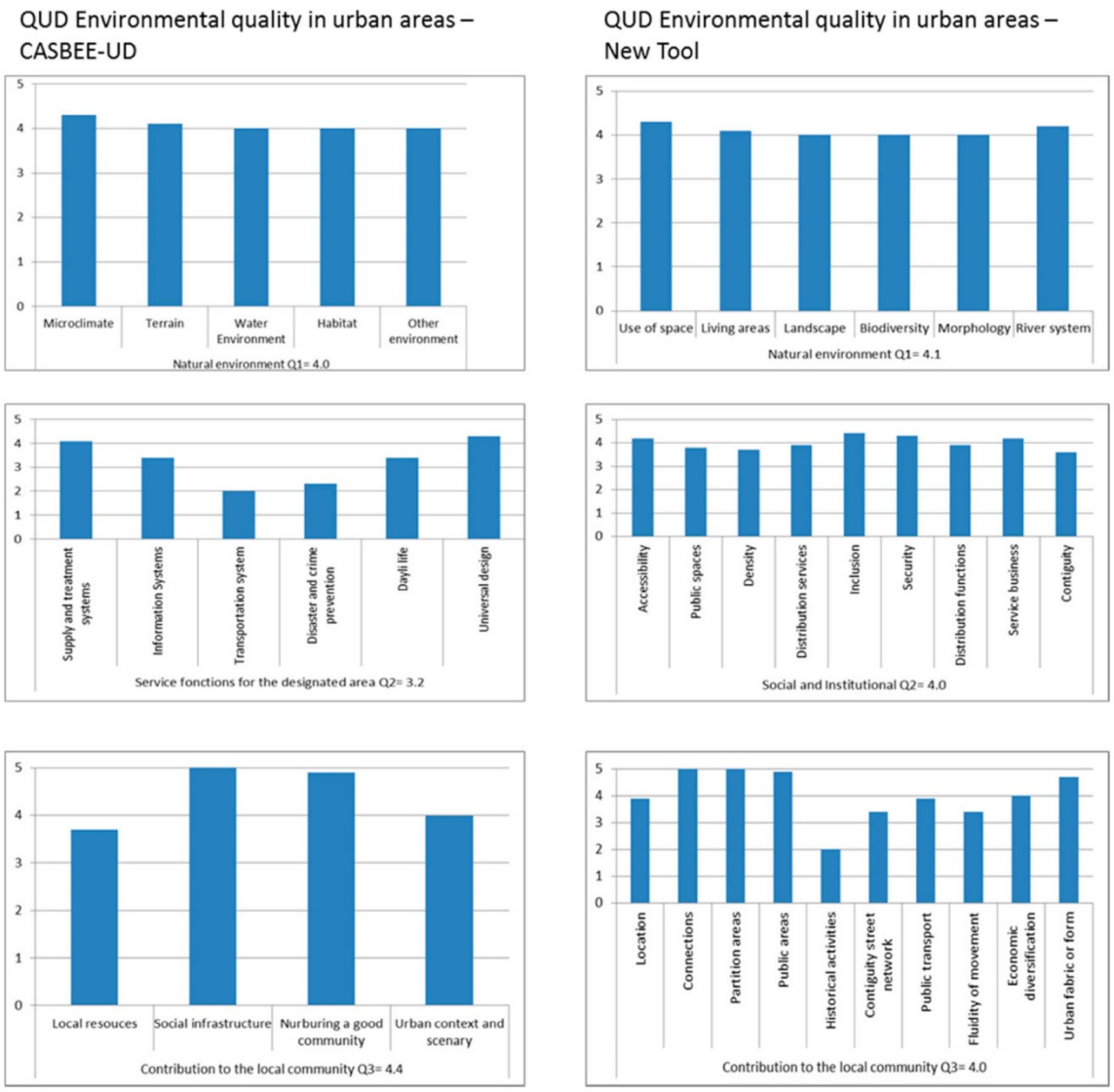

Figure 3-3 Comparison results of environmental quality (Q_{UD}) assessment

In the areas evaluated, some the local expectations were not respected, a circumstance that does not allow the new tool to assign a maximum point score for the social aspects. However, in general, for social aspects the new tool gives a higher score than the CASBEE-UD. Indeed, the Environmental Quality Assessment (SQ_{UD}) for the new tool has a score of 4.0 compared to a score of 3.8 with the CASBEE-UD. In the Load Reduction (SLR_{UD}) evaluation the two tools are almost equal in their assessments. This very similar result was expected, because for this evaluation the CASBEE-UD structure was left almost unchanged;

only two indicators were added in the evaluation of social aspects and two for the evaluation of economic aspects.

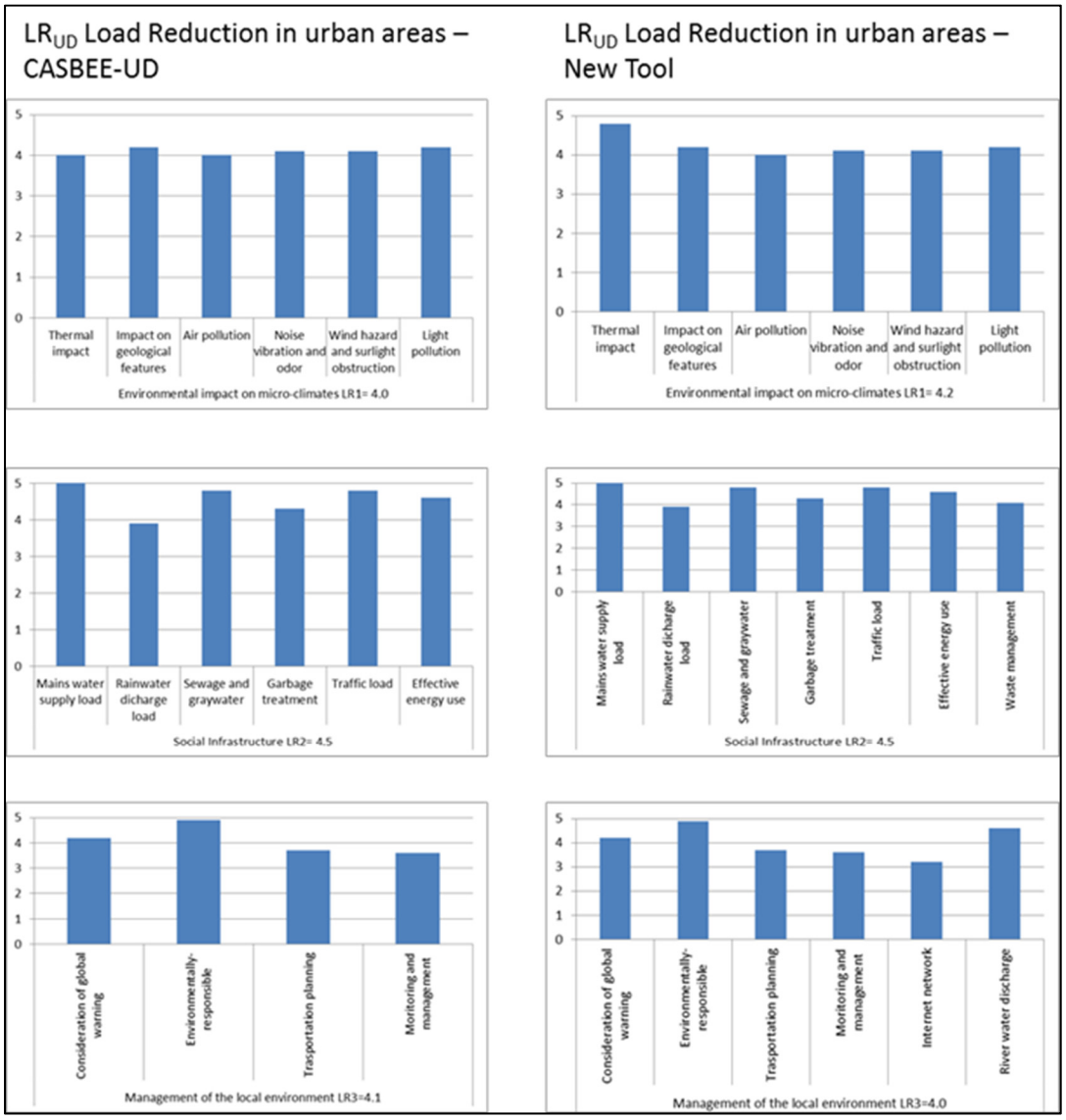

Figure 3-4 Comparison results of Load Reduction (LR_{UD})

The results of the integration of socio-economic aspects in the CASBEE-UD are reassuring, as the radar chart shows that there are differences in the evaluation of the same territory (Figure 3.5). Figure 3.5 shows the improvement of the CASBEE-UD evaluation tool taking

into account the socio-economic aspects of integration (in red) compared to the results of the CASBEE-UD without socio-economic criteria (in blue).

The strategy used for the assessment of boroughs in urban areas poses a difficult challenge as it must take into account various objectives and tasks that are often inconsistent with local socio-economic and political realities.

From the results obtained here, we can see that the dominant solution is the evaluation tool with socio-economic indicators. Based on our analysis of the results of this study, the proposed methodology improves the ability of an assessment tool to carry out quantitative and multidimensional assessments of specific territories.

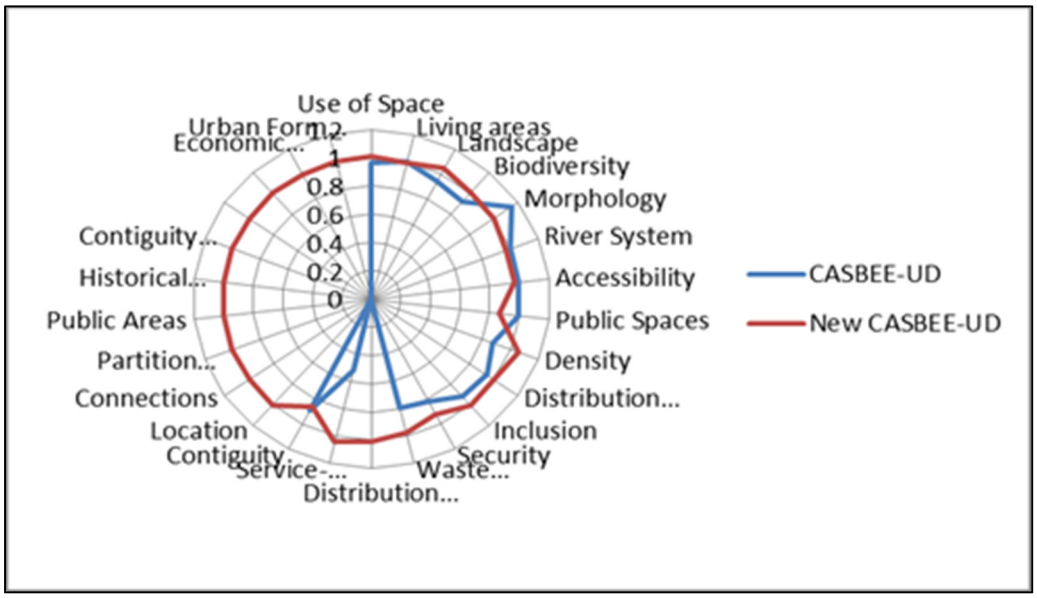

Figure 3-5 Evaluation result in radar form depicting the final score of each tool

As shown in Table 3.10, the AHP revealed that the new assessment tool that incorporates 12 variables performed better than the CASBEE-UD.

Tableau 3-10 Multi-criteria AHP evaluation results depicting final score of each alternative

Dimensions	Base	Variant 1 (Casbee-UD)	Variant 2 (New Assessment Tool)
Environment			
Alternative Weight	1.00	0.43	0.57
Social			
Alternative Weight	1.00	0.27	0.73
Economic			
Alternative Weight	1.00	0.00	1.00

3.10 Discussion

Assessment tools are structured to take into account economic, social and environmental sustainability. However, the majority of these methods evaluate "green" performance regardless of social and economic issues and problems (Cole, 1999 cited by Sev, 2011).

In fact, an evaluation tool must take into account multiple aspects, including: (i) the availability of resources, (ii) economic viability and (iii) social acceptance. (Cole, 2005 cited by Sev, 2011). For example, Japan has developed innovative policies for its cities (e.g., Tokyo, Osaka) in recent years utilizing their CASBEE-UD assessment tool.

The objective of this study was to integrate more socio-economic aspects into the CASBBE-UD evaluation tool and to apply and analyze its evaluation in four boroughs of the city of Montreal. The comparison of two tools (the CASBEE-UD and the new tool) gave us the opportunity to appreciate the contribution of the integration of these indicators. The evaluation assigned a positive score for environmental efficiency based on the environmental indicators that are already in the structure of the tool. But what we were most interested in was the evaluation of the territory in terms of the socio-economic indicators that we integrated. The evaluation gave a rating on these aspects based on site security, affordability and accessibility.

Regarding the evaluation of economic indicators, the new tool gave a rating based on employment differentiation, the distribution of services and historical activities and the contiguity of the street network. However, with the CASBEE-UD methodology, we could not compare economic indicators with certain social indicators because these indicators are not included in the manual, such as the urban renewal index, the proportion of pedestrian-priority streets, the number of schools, the number of services per capita and so forth.

As demonstrated in this study, the CASBEE-UD assessment tool needs to be structured so that all dimensions can be covered with appropriate indicators. We used the inclusion and security of the site as an example. Another problem with CASBEE-UD is the distribution of the weight of the different criteria, as certain performance criteria for these tools have a greater positive impact on the environment than other criteria. The performance criteria must be applied locally and weighted according to the situation of each site. Therefore, weighting should be done according to a hierarchy of criteria developed at the local level. This local weighting can meet both community expectations and pre-set objectives when designing a project. A consensus-based weighting system, developed according to local and regional priorities, will more accurately reflect community assessment.

Another criterion that the CASBEE-UD tool does not address is to evaluate the presence of affordable housing. Having affordable homes is necessary in a neighborhood, as it allows for a social mix, access to different types of jobs and also allows a neighborhood to enjoy a level of stability. Again, we found that the specificity of a site must be taken into account. Building materials and technology, the labor supply, the availability of water and electricity are the main site-specific factors that are generally not taken into account.

Most assessment tools encourage the use of public transit and bicycles which is easy in the urban areas of most developed countries. However, CASBEE-UD is the only tool that does not have indicators in the transit system evaluation category “MOBILITY AND TRANSPORT” (Subcategories “Public transport and other sustainable alternatives”—No

Indicators “Efficiency of public transport”—No Indicators) because public transport is the most typical means of transport in Japan.

It should be noted that in some cases CASBEE-UD assigns a score almost equal to that of the new tool. For example, in transport where CASBEE-UD offers a score of 3.7, with the new tool New CASBEE-UD the score is 3.9. This can be explained by the fact that CASBEE-UD has only two indicators to evaluate transport. We also observe that historical environmental protection is another problem in the assessment. The CASBEE-UD does not provide a criterion for protecting the cultural context or the historical environment. However, certain criteria related to this dimension are covered, such as the impacts of development on neighbors, the local community, relationships and sensitivity to the archaeological and historical context. Social and economic dimension criteria can be said to confer a unique power to the CASBEE-UD to achieve sustainability (Cappuyns, 2012; Sev, 2011).

An assessment tool that can measure additional dimensions of sustainability can encourage dialogue among stakeholders. As support for this statement “for evaluation tools to be beneficial during the design process, the performance criteria of the tools must be considered as quickly as possible” (Sharifi and Murayama, 2014; Cities alliance, 2007) because, if the target performance levels are not achieved, subsequent changes will take longer, cost more and citizens may never get involved in the life of their neighborhood.

3.11 Conclusions

The application of this methodology in the four boroughs of the city of Montreal has made it possible to highlight the limits of this proposed evaluation method. One of the limitations is that it bases its calculations on indicators that are themselves derived from other studies, as well as on indicators used by the four municipalities. This leads to a dependence on other tools whose users does not necessarily control the outputs. Another limit lies in the aggregation of criteria. To give a performance score for each dimension, it is necessary to aggregate the performances of all the criteria. This makes the scores unreliable, as on many

occasions it was not possible to aggregate them and so we had to force the performance of certain criteria to achieve a coherent result. A third limit, one that was not taken into consideration by the authors, is stakeholders' participation, as this was not within the objectives of this study. The AHP method remains easy to use and to understand. New aspects may be taken into account in the form of indicators (e.g., indicators linked to the institutional component) or of criteria (to, for example, improve urban comfort). Concerning the aggregation of indicators and criteria, the method of determining the weighting coefficients is less transparent but remain understandable and usable and above all it makes it possible to verify the coherence of the choices.

Assessment tools and in particular the CASBEE-UD, are indeed powerful tools notwithstanding the CASBEE-UD's lack of socio-economic criteria, because, as already highlighted, its approach to evaluating the territory offers the possibility to not only evaluate a project but also to contextualize it to the rest of the territory by evaluating the entire external environment. It is true that for use outside Japan, the CASBEE-UD should be adapted to each country or region, taking into account environmental weightings and references to local codes and standards (including the addition of criteria to assess the level of public and active transportation). Today, the most widely used tool remains LEED, currently the most widely used standard in North America and one that has been widely adapted for use in countries outside of North America (Cappuyns, 2012).

We believe this study can be particularly useful at the decision-making stage, as it is a crucial step where stakeholders play a key role in defining neighborhood sustainability goals. In decision-making, it is important to choose a tool that allows a more complete assessment of the territory. Indicators describing the local context therefore play an important role and can help decision makers build new neighborhoods based on local expectations. The dimensions of sustainability must be clearly identified in order to associate them with local criteria that will best capture the problem of the contextualization of a neighborhood in relation to the rest of the territory. It is true that in a city there are different areas (empty spaces, industrial wastelands, etc.) that are not easy to contextualize to the rest of the territory. It is in these

cases especially that an evaluation method and local indicators can facilitate the role of stakeholders in decision-making and project development.

The validation of the methodology can be carried out by searching for references. This requires the application of the proposed method to several case studies in order to obtain sufficient statistics. More fundamentally, any decision support system requires strong decision-makers to implement it. Only consultation and negotiation can make it possible to choose realistic and applicable indicators and to build a method for using them to arrive at a reasoned and satisfactory decision. We hope that by making available a robust and reliable methodological approach we can convince decision-makers of the advantages in implementing such tools. We believe that future research should focus on developing a comparative analysis of socio-economic aspects at the local level and on using a methodological approach that is sensitive to the expectations of the local community. Our orientation in future research is to select and use a battery of local indicators in a specific urban project, for example in a brownfield redevelopment, in order to better contextualize these territories to the rest of the city taking into account local expectations.

Acknowledgments: The authors would like to express their appreciation for two laboratories of the École de Technologie Supérieure—GRIDD and STEPPE—for their financial support in conducting this study. Thanks should also go to all of the experts we consulted for their time and input during the realization of this article. Finally, much gratitude is extended to two anonymous reviewers for their valuable comments on this paper.

Author Contributions: Francesco Cappai conceived the project, the main conceptual ideas and the outlines of proof and made numerical calculations for the suggested experiment. Daniel Forgues and Mathias Glaus developed almost all the technical details and verified the numerical results of the case study. Francesco Cappai wrote the manuscript.

Conflicts of Interest: The authors declare no conflict of interest.

CHAPITRE 4

SOCIO-ECONOMIC INDICATORS FOR THE EX-POST EVALUATION OF BROWNFIELD REHABILITATION: A CASE STUDY

Francesco Cappai[a], Daniel Forgues[b], Mathias Glaus[c]

[a], [b] GRIDD-ÉTS – Département de génie de la Construction, École de Technologie Supérieure, 1100 Notre Dame W, Montréal (QC), Canada H3C 1K3
[c] STEPPE-ÉTS – Département de génie de la Construction École de Technologie Supérieure, 1100 Notre Dame W, Montréal (QC), Canada H3C 1K3

Article publié dans « Urban Science Journal » Septembre 2018

4.1 Abstract

The reuse of brownfields is becoming a necessary option to meet the current requirements of urban densification and for the preservation of agricultural land, as well as for improvement in the quality of life. The purpose of this article is to evaluate the main objectives and benefits of a rehabilitation project implemented in Canada. The rehabilitation of the brownfield site Lachine-Turcot-Petite Bourgogne in Montréal was analyzed according to four indicators (revenue, average cost of rent, rental usage, and home resale price). The findings of the study demonstrate that the expectations (socio-economic benefits derived from Southwest borough—City of Montréal) of the local community were not respected and that the initial objectives of the project changed during its implementation. In particular, the average rent increased considerably after four years, by 165.47% in the period 2001–2006. The percentage of resident homeowners increased from 89% to about 95% in 10 years, and in the 1996–2014 periods the total income per household increased from about $25,000 to about $78,000. We propose an evaluation tool that integrates ontology of the elements necessary for decision-making and local indicators related to the environmental and socio-economic components with the goal of meeting the expectations of the local community.

Keywords: sustainable neighborhood; brownfield; sustainability assessment; ex-post analysis; adaptability and applicability

4.2 Introduction

A sustainable urban community requires the involvement of stakeholders in the early expansion phases of the urbanization process, as their contribution is key to the creation of innovative, viable urban development. Land use policies that preserve agricultural and other green spaces are increasingly important to respond to a city's increasing densification and improve the quality of life of its residents and users.

The revitalization of brownfields indicates the willingness of cities to densify and give them a specific increase in property assessment values while allowing for the preservation of agricultural land and simultaneously minimizing commuting distances.

The United States Environmental Protection Agency (EPA, 2004) estimates that there are about 450,000 brownfields in the US, while the US Conference of Mayors (2006) puts the figure at 600,000 sites. In Canada there are about 35,000 contaminated sites according to the National Round Table on the Environment and the Economy (NRTEE, 2003). Most of these sites are located in the urban centers of Montreal, Toronto and Vancouver (De Sousa, 2003). The redevelopment of these areas is complex and the current development initiatives are mostly oriented towards investments to improve them in terms of their environmental aspects.

Awareness of the potential revitalization of brownfields and the contextualization of these areas to the rest of the city is very recent. The first studies on brownfields only date from the early 1990's. These are areas that have been neglected over time, most often due to the presence of soil contamination. Different theories focus on the concept of location in making decisions on the revitalization of a contaminated site, such as the real estate market, location, community, use and accessibility (Land, Group, Quality, & Management, 2017). As in the

land use theory, emphasis is given to location as the main reason for creating enterprises, followed by market demand and the availability of human resources (Doick, Sellers, Castan-Broto, & Silverthorne, 2009). Given that many brownfields are located near city centers, the competitive advantage theory emphasizes the importance of local government support to attract investors (EPA, 2004). New industrial and entrepreneurial zones are being created in accordance with policies to attract private investment with incentives for small and medium enterprises (De Sousa, 2003). The reluctance to fully revitalize these areas is related to the inertia of federal and local governments to initiate the redevelopment process, which in turn is due to the low level of understanding and of accepting the incorporation of the participatory and collaborative approaches required for the management of complex projects (Tonin, 2014). These sites could be cleaned up to meet current environmental standards and be processed for reuse according to the expectations of citizens and for use in new economies, including for housing and improvement of the quality of life for future residents (Adams, De Sousa, & Tiesdell, 2010; De Sousa, 2003, 2006). Some approaches address the efficient use of land and improved modes of transportation, such as allowing for increased accessibility and travel options (Cundy et al., 2013; Greenberg & Lewis, 2000; Luederitz, Lang, & Von Wehrden, 2013; Moussiopoulos, Achillas, Vlachokostas, Spyridi, & Nikolaou, 2010). Other approaches address the smart city concept, focusing on accessibility, the ability of a city to offer its citizens goods, services and activities according to their expressed desires (Doick et al., 2009; Nijkamp, Rodenburg, & Wagtendonk, 2002; Pediaditi, Doick, & Moffat, 2010). A common feature of all of these approaches is the transformation of the current neighborhood development process, by the redevelopment of existing sites (Ng, Cook, & Chui, 2001; Turcu, 2013) and by designing new urban neighborhoods (Suzer, 2015). Many of these approaches are based on generic principles that are considered to be equally applicable to different situations (Doick et al., 2009; Moussiopoulos et al., 2010; Pediaditi et al., 2010). The general assumption underlying these principles is that sustainable urban organization increases the long-term benefits for residents, businesses, developers and governments (Hernández-Moreno & De Hoyos - Martínez (2010) cited byLuederitz et al., 2013).

The involvement of stakeholders is essential for defining strategies to revitalize brownfields and to reconcile these strategies with the city (Cappai, Forgues, & Glaus, 2016). The most commonly used assessment tools (BREEAM, 2015; CASBEE-UD, 2014; LEED-ND, 2015), (SBTool, 2004)) have a complex structure and do not provide the desired results for the analysis of brownfield projects. They do not include the involvement of all stakeholders; their indicators are not equally divided between the three dimensions of sustainable development (Sharifi & Murayama, 2013) and do not take into account the local context and expectations (Kepaptsoglou, Karlaftis, Gkotsis, Vlahogianni, & Stathopoulos, 2015). A rigorous approach and the use of appropriate indicators prove to be a necessity for the success of such projects.

The objective of this case study is to estimate the objectives of the Lachine-Turcot-Petite Bourgogne—an urban redevelopment project for an industrial brownfield in Montréal—and compare them with the socio-economic benefits after 14 years of implementation. This evaluation demonstrates the need for an effective evaluation tool for all project phases if local objectives and expectations are to be met. It also proposes ontology of the elements required for effective decision making, as well as indicators related to environmental and socioeconomic components that should be incorporated into this assessment tool and the need to evaluate the project during its development to focus the initial objectives of the project.

This article is structured as follows: (1) An overview of the revitalization of brownfields based on theoretical knowledge and practical experience (Context); (2) an analysis of the most commonly used brownfield redevelopment approaches (Literature review); (3) the methodology and case study of the industrial site canal Lachine-Turcot-Petite Bourgogne in Montréal; and (4) the results and conclusions, including recommendations and possible research directions.

4.3 Brownfields: Theoretical Knowledge and Practical Experience

According to literature review studies, urban revitalization interventions are not focused on poverty and improving urban services, but on creating a mix of income (2003) This research shows that poverty is not supported and that it is rather the territorial concentration of poverty that is attenuated by the influx of wealthier populations (Talen et al., 2013). Other research, thus, shows an instrumentalization of disadvantaged areas because they are metaphors of poverty and that urban revitalization becomes a symbol of discourse and political action (Wedding & Crawford-Brown, 2007).

Although our object of study does not focus on the gentrification and the increase of the land values, it remains essential to approach this phenomenon, to understand the transformations underway in the brownfield Lachine-Turcot-Petite Bourgogne. In studies conducted by Préfontaine (2008) the concept of gentrification is often synonymous with gentrification or at least a change in social composition through displacement or replacement of the community. This displacement refers to the departure of traditional populations, as a consequence of changing market conditions; the replacement of the population is by the arrival of new people, which changes the social composition of the neighborhood to such an extent, that it results in a loss of sense of home or feeling of community. This carries a higher cultural or economic capital (Wedding & Crawford-Brown, 2007).

The economic orientation of development aims to stimulate the land and real estate market as well as to attract new customers to a neighborhood. The influx of new residents or new businesses is intended to fund the expansion of public services that will improve transit supply. The public actor then gives importance to the economic actors by participating in the effervescence of the land and real estate market through gestures of developments affecting the public space or by adapting the regulations according to the needs of the promoters.

In an urban rehabilitation process, as in other development processes, the use of a well-structured model is important to integrate these areas with the rest of the city while taking

into account the needs of the local community and the objectives of public and private actors. The structure of these models must be supported by a decision-making process. The first steps in such a process should involve the participation of all stakeholders and the selection of indicators to measure the effectiveness of the project. In many cases, the models used to date have been flawed due to a lack of stakeholder involvement and the selection of local indicators to identify revitalization issues.

A number of decision analysis tools have been developed for the redevelopment of brownfields. Of the many tools that are available, some are intended almost exclusively for the evaluation and restoration of the environment, and others are designed to assist in interpreting life cycle analyses (Cappuyns & Kessen, 2012). In the 1990's, an assessment tool to support the sustainability of cities was implemented in the United States. The Green Building Council in Energy and Environmental Design (LEED-ND, 2015) developed the LEED New Development, which offers guidelines and certification as an important instrument for reducing the environmental impacts of the construction industry (Wedding & Crawford-Brown, 2007). In recent years LEED has made the effort to adapt this certification at the neighborhood level (LEED-ND, 2015) LEED for neighborhood). This effort makes it clear that it is at the neighborhood level where economic gains and efficiencies are significant. These can be achieved through the integrated planning of land, transport and infrastructure which easily adapt them to the concept of intelligent growth and sustainable building principles (Talen et al., 2013). These tools focus mainly on building construction and financial returns; it does not deal with issues of livability and social diversity (Sharifi & Murayama, 2013). In addition, most of the indicators that attempt to measure progress are focused on global, regional or municipal issues and cannot be site-specific (De Sousa, 2006). Indicators for assessing brownfield redevelopment should include several features, such as interconnectivity with other areas and accessibility. An indicator must serve the objectives of the project and be able to define the entity which it is intended to measure. For example, reducing the need to demolish the existing buildings serves multiple objectives: it avoids losing the identity of the context (cultural dimension), preserves natural resources and reduces waste (environmental dimension) while decreasing management costs by avoiding

unnecessary new construction (economic dimension). In addition, as De Sousa (2006) states, indicators are needed for the built environment, particularly for brownfield sites. LEED evaluation results, in most cases, are not those expected by users. Other authors mention several methods for measuring the efficiency of regeneration projects in urban areas, but as they say, these methods only give partial results because the measures undertaken focus very little on contaminated sites and their methods for allocating points are unclear and not very intuitive (Nijkamp et al., 2002). This is the case for Greenberg & Lewis (2000), who conducted important research on brownfield redevelopment projects, but their studies have not provided an ex-post assessment tool. Meanwhile, other work by Bacot and O'Dell (2006) cited by De Sousa (2006) suggests some indicators (such as number of affordable housing, number of hectares of contaminated land, types of transportation) for measuring the viability of brownfields according to environmental and economic factors. What results from these studies is that the indicators are very limited for assessing brownfield redevelopment impacts (e.g. no discussion of habitability, social diversity, or green building design). More importantly, their method does not take into account a project's success (ex-post evaluation). Other methods have been designed to assess the degree of success in brownfield redevelopment, but they do not provide for measuring the success or impact of a project in relation to other areas of interest (Cappuyns & Kessen, 2012; Nijkamp et al., 2002), nor do they offer any means to determine if the project objectives have been achieved.

4.4 Methodology

This case study uses a strategy based on the use of indicators to measure the performance of a revitalization project in an industrial wasteland. The goal is to make an ex-post analysis of the project to determine whether the project’s objectives have been achieved. The methodology consists of three steps, which are outlined in Figure 4.1 and described below.

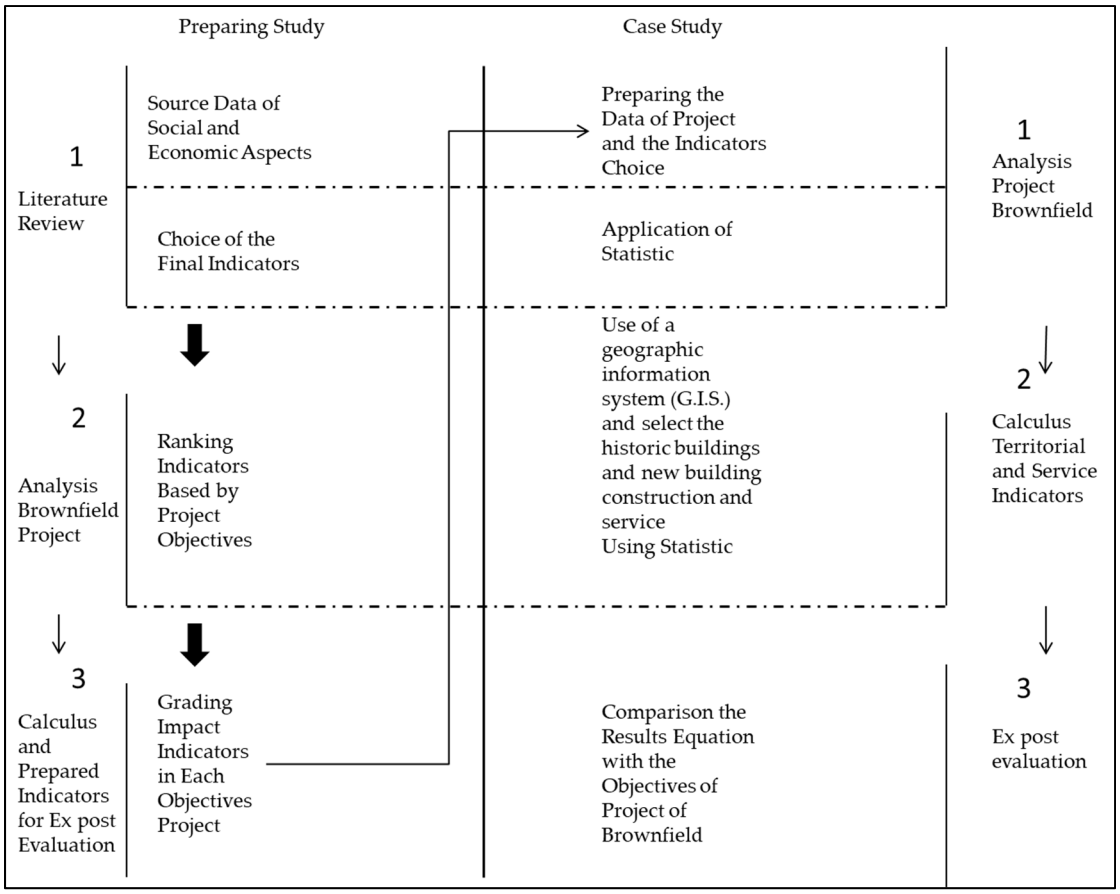

Figure 4-1 Methodological approach to ex-post evaluation of the revitalization project

The first step consists of choosing the socioeconomic indicators and collecting the data associated with each indicator that will allow us to select the variables (dependent and independent) with which to measure the indicators for each dimension. The indicators, their sources, and the time series are indicated in Table 4.1.

The decision to use these indicators is made, firstly for the ease of retrieving the data, but also because they give a very clear perspective of the actual situation after the revitalization project. The variable of the gross rent (average) gives us an outlook of the level of gentrification and also gives us the opportunity to understand which people have decided to settle in the former wasteland area and their income level. This explains the link between the rent variable and the total family income. The third variable (tenure) provides data to evaluate the project's performance on housing affordability. The fourth variable (resale price

of houses) gives us the opportunity to understand the effect of gentrification and the economic benefits provided to the real estate market.

Tableau 4-1 Indicators used for ex-post evaluation

Indicators	Source	Time Series to be Considered
Gross rent (average)—Amount paid per month ($/month)	National Statistics Offices and/or local, municipal data, borough data, home sales offices (G. o. Canada; Offices, 2015; RESO, 2002)	The series should include number of years before and after the project (about 20 years)
Total income (average)—Total annual income ($/year)	National Statistics Offices and/or local, municipal data, borough data (G. o. Canada; Offices, 2015)	15–20 years
Tenure—The number of owners occupying their own home (number of owners/houses)	National Statistics Offices and/or local municipal data, borough data, home sales offices, estimated door-to-door (G. o. Canada; G. o. C. P. Canada; Montréal, 2018; Offices, 2015; RESO, 2002)	Project start to realization
Resale price of houses (average)—($/houses)	Statistics Canada, Southwest Borough, RESO (G. o. Canada; G. o. C. P. Canada; Offices, 2015; RESO, 2002)	The series start after the sale by first owner

The second step is devoted to the use of a geographic information system (G.I.S.) that will allow us to trace the project's boundaries (the selected brownfield) and select the historic buildings and new building construction pertinent to the revitalization project. This identification step makes it possible to determine the magnitude of the project as well as its interconnection with other contexts and/or neighborhoods. The selection and detailed measurement of the areas of each building's floor space is also conducted here, in order to categorize and note the intended use of each space. This step allows us to fully ascertain the total built space and their characteristics (type and use), as well as to identify the total area available for housing and services.

The third step is the analysis and evaluation of the project. In the analysis stage, we examine the information we have collected (comparing it with neighboring neighborhoods) to better understand the relationships between neighborhoods that share the same characteristics. This step ensures that the information is complete, valid and understandable. After collecting all

the data and knowing the results of the analysis in order to make a decision, in the evaluation stage we present the information in both qualitative and quantitative formats. Using the data accumulated in step one and local demographic statistics (see the Formulas (9) and (10)), we will be able to calculate the percentage rental income and the average for each year of our indicators.

Équation 8

$$x_i = \frac{\gamma_2 - \gamma_1}{\gamma_1} \times 100 \tag{9}$$

$$x_m = \frac{\sum x_i}{n}, \tag{10}$$

x_i = %; γ_1 = Monthly rental fees for (nth) year; γ_2 = Monthly rental fees for (nth + 1) year

x_m = average; n = number of years of the time series

In the same step, using an outcome evaluation, we will also describe the progress in achieving our indicators in selected time series. This assessment will indicate whether the project's objectives have been met, and to what level; for example, determining if the social diversity and the relocation of low-income families planned in the objectives have been achieved.

4.5 Case Study: Industrial Wasteland of Canal Lachine-Turcot-Petite Bourgogne (Montréal, Quebec, Canada)

The Southwest borough is located south of the island of Montréal. From an architectural point of view, the two urban contexts have similar characteristics to other boroughs. If we consider the different historical stages of development of the City of Montréal and the Southwest borough, we can note that in the borough there is a marked presence of single-family dwellings and buildings (duplex and triplex) which do not exceed the three floors. These buildings were built during the 1850s in the period of pre-industrialization. They are

now mixed with buildings built during the industrialization period. This sector has been a catalyst for Montréal's urbanization and an inseparable part of the identity of the Southwest.

In this last period, in the Canal Lachine-Turcot-Petite Bourgogne sector, there was a strong presence of housing where the architectural features are simple and away from the characteristics of the rest of the City of Montréal and the Southwest borough by the presence of a number of industrial buildings. After the closure of most factories in this area in 1970, there was a migration of residents and the area was abandoned. Until the end of 1990, the sector suffered from a decline in population and economic decay. Household income prior to the brownfield rehabilitation was the lowest in the city and borough (Statistics Canada, 2000). A key element of Southwest socio-economic data is the cost of housing. Indeed, the rehabilitation of land can make new housing available, but it is important to ask questions about the impacts of the construction of new housing according to their type and price. A characteristic of people living in the borough is the high mobility of individuals. The borough's mobility rate is 52% of residents who change housing (Southwest Development Plan, 2002; RESO, 2015; Parks of Canada, 2018; Ville de Montréal, 2018). This rate is slightly higher than the average for Greater Montréal. Of these moves, only one-third remained in another borough. The Southwest is, therefore, characterized by high mobility within its territory. The average income of the Southwest population is lower than the average income of the island. The average income of a family before the rehabilitation of the brownfield Canal Lachine-Turcot-Petite Bourgogne was $45,044 and the average household income was $36,683, both below the Montréal average (Statistics Canada, 2000). In addition, the borough ranked third among Montréal boroughs for the lowest household incomes. Finally, nearly 41% of the borough's population lives below the low-income threshold, the second highest rate in Montréal boroughs. The three main sectors of activity for residents are sales and services with 26.9% of jobs, business, finance, and administration with 21.5%, as well as trades, transportation, and machinery with 12% (Statistics Canada, 2011). Compared to the Montréal average, the proportion of the first two sectors of activity is slightly higher at the borough level. Most jobs in the borough's industrial sector are in manufacturing. They represent 24.2% of borough jobs. The second largest industrial sector in the borough is

transportation and warehousing, accounting for 10.5% of jobs, or 3040 jobs (Southwest Development Plan, 2002).

The Lachine canal industrial wasteland is located in the Southwest borough of Montréal. It has an area of over 1,176,900 m^2 and experienced significant industrial growth beginning in the late 1800s. Since the 1990s, municipalities have realized the opportunities made possible by better managing a city's transformation. In some cases, cities have implemented laws and regulations to give private companies the opportunity to develop brownfield sites while meeting the requirements of planned urban development. For example, in Quebec (Canada), these powers are granted under the Act respecting municipal industrial real estate (LIIM) of the law on planning and development (LAU) and the Municipal Skills Act (LCM, art. 32, 33, Parks Canada, 2018 Ville de Montréal, 2018; MAMOT, 2018) (Ministry of Municipal Affairs, Regions and Land occupancy and with the orientations of Strategic Plan 2009–2013). The "Affaires municipales et Occupation du territoire" MAMOT is responsible for supporting the municipalities and promoting a sustainable and integrated approach for the benefit of citizens.

The Government of Canada has put in place other programs for the rehabilitation of contaminated sites. For example, in May 2002, the National Assembly passed Bill 72 (National Assembly – Québec Official Publisher, 2002, chapter 11), the Act to amend the Environment Quality Act Land and other legislative provisions relating to protection and rehabilitation, and, in February 2003, the Council of Ministers adopted The Land Protection and Rehabilitation Regulation (2018). Recently, the Ministry (March 2017) has set up ClimatSol, a program to help rehabilitate contaminated land in Quebec municipalities (Governement of Canada, 2018).

This brownfield covers a very large area, as it extends for the entire 14 Km length of the navigable section of the Lachine Canal. The revitalization project is only concerned with a part of this total area, between Wellington Street (in Griffintown) (located about 750 m from the Old Port) and the Cote Saint-Paul locks, a length of about 4811 m. The Lachine Canal,

inaugurated in 1825, opened the upper Saint-Lawrence to navigation and played an important role in the development of Western Canada (source: Parks Canada and the City of Montréal). The first canal rehabilitation was carried out by the Department of Public Works Canada, which built a bicycle path in 1977 as part of "ACTION 77" to create an urban recreational park. The management of part of the canal by Parks Canada in 1978 helped to rehabilitate and save the environment around the canal. The revitalization of this industrial site is not yet finished, but the major work has been done. There are still vacant and contaminated areas in this neighborhood, posing several problems for the local government and the community. However, the Lachine Canal is also one of the most strategic locations for future development and economic revival in the borough. The indicators selected to evaluate this case study: gross rent, total household income, housing tenure, and resale price of houses, were chosen because they are interconnected with other dimensions such as the interconnection of indicators.

Tableau 4-2 Project objectives and indicators used

Project Objectives	Associated Indicator (Case Study)
Promote mixed-use development (including housing, offices, and businesses) of vacant or underutilized sites in certain portions of the area	Total income (average)—Total annual income ($/year)
Maintain and consolidate economic activities in certain places	Resale price of houses (average)—($/houses)
Support the rehabilitation of contaminated sites to facilitate their development	
Encourage the relocation of some companies incompatible with their environment	Tenure—The number of owners occupying their own home (number of owners/houses)
Improve the accessibility of landlocked sites and strengthen the links between communities located on both sides of the canal	
Encourage the relocation of households by promoting affordable rentals	Gross rent (average)—Amount paid per month ($/month)

Project sponsors included: Parks Canada, the City of Montréal and several private partners. Initially, the project cost more than $120 million. The Government of Canada, the City of Montréal and the City of Lachine have invested $100 million in a variety of revitalization works which will transform the landscape of the Lachine Canal and surrounding area. These

public funds generated private investment of about $250 million (Government of Canada—Parks Canada, 2018). In Table 4.2 the project objectives and indicators used associated with each orientation are described.

The initial objectives of the project (derived from the Montreal City—Southwest District Development Plan, 2002 and the Montréal Master Plan—Synthèse des orientations Mars 2011) were as follows: (1) To allow the residents (low-income) of the borough to settle in industrial wastelands; (2) improve the existing built environment; (3) conserve and revitalize historic buildings and convert them; (4) increase affordable and social housing; (5) improve the economic situation of the neighborhoods surrounding brownfields; (6) improve inclusion and the social mix.

As shown in Table 4.3, these indicators generally measure economic factors, but these factors are also interconnected with social aspects. This list is not comprehensive enough for a complete ex-post evaluation, but it is sufficient to determine some responses about the project objectives and to assess its performance from a socio-economic perspective.

Tableau 4-3 Indicators used for the ex-post evaluation of the canal Lachine case study

Indicator	**Source**	**Time Range**
Gross rent (average)—($/month)	Statistics Canada, Open Data Canada, Southwest Borough (Lewicka, 2010; Offices, 2015)	1996–2015
Total income (average)—($/year)	Statistics Canada, Southwest Borough (Marsal-Llacuna & Segal, 2017; Offices, 2015)	1996–2011
Housing tenure—(N. owners/houses)	Statistics Canada Open Data Canada, Southwest Borough, RESO (Montréal, 2018; Offices, 2015; RESO, 2002)	1996–2015
Resale price of houses (average)—($/houses)	Statistics Canada, Southwest Borough, RESO (Offices, 2015; RESO, 2002)	2001–2013

The selected indicators also include the neighborhoods bordering the industrial wasteland, in order to understand the differences between the territories that were not involved in the

revitalization project. In this context, we also included the adjacent boroughs and municipalities on Montréal Island (Table 4.4).

Tableau 4-4 Gross rent - the monthly rent data of the Montreal Island

Year / Municipality	1996	2001	2006	2011	2014
Montréal	$452.38	$502.00	$604.00	$695.00	$714.00
SouthWest (Borough)	$386.00	$489.00	$569.00	$649.00	$689.00
Canal Lachine	$324.00	$336.00	$892.00	$1023.00	$1421.00
St. Anne Bellevue	NA	$557.00	$657.00	$693.00	$724.00
Beaconsfield	NA	$684.00	$856.00	$942.00	$964.00
Pointe Claire	NA	$763.00	$862.00	$923.00	$1110.00
Dollard Ormeaux	NA	$579.00	$694.00	$735.00	$813.00
Dorval	NA	$618.00	$670.00	$738.00	$795.00
Cote Saint Luc	NA	$691.00	$845.00	$892.00	$908.00
Hampstead	NA	$888.00	$725.00	$732.00	$810.00
Westmount	NA	$1249.00	$1239.00	$1435.00	$1436.00
Montréal Est	NA	$390.00	$601.00	$639.00	$634.00

In the second step, with the use of G.I.S., we selected the territorial dimensions associated with the brownfield and identified the buildings located in the industrial brownfield. The purpose of this step is to classify the historical buildings that were involved in the revitalization, the newly constructed buildings and their purpose, and any non-abandoned factories that are still in operation (Figure 4.2). Figure 4.2 shows a part of the industrial site in which all of the buildings have been identified according to their category and indicated with different colors. Historic buildings that are still used for industrial purposes are in blue. Only one historic building remains, that of Canadian Bag (Canadian Bag, 1913), a company that manufactured jute and cotton bags. In 1989, it was converted into a housing cooperative for low-income families (this is indicated in red). The restored buildings that are intended for commercial and residential purposes are in red, newly-built buildings intended for commercial and residential use are in yellow, and buildings designated for affordable housing are in green (the last is indicated in Table 4.5). As demonstrated in Table 4.4, with the use of G.I.S., the interior areas were calculated for each category of building.

Figure 4-2 Historic buildings and new construction (Geographic Information System(G.I.S.))

Legend: industrial building in red, new construction in yellow historical building in blues

Tableau 4-5 Categories of buildings in the brownfield canal Lachine-Turcot-Petite Bourgogne

Building Category	**Building Footprint**	**Number of Buildings**
Historical	150,888 m^2	23
New construction	37,322 m^2	13
Industrial restored	25,576 m^2	6
Affordable housing	4280 m^2	1

Next, as shown in Figures 4.3 and 4.4, using municipal statistics and RESO (2002) data, we compared the resale data of three types of dwellings (single-family, condominium, and duplex). We have taken into consideration the Southwest, brownfield canal Lachine, and the City of Montréal data as they relate to the period 2001–2013 in order to observe their trends.

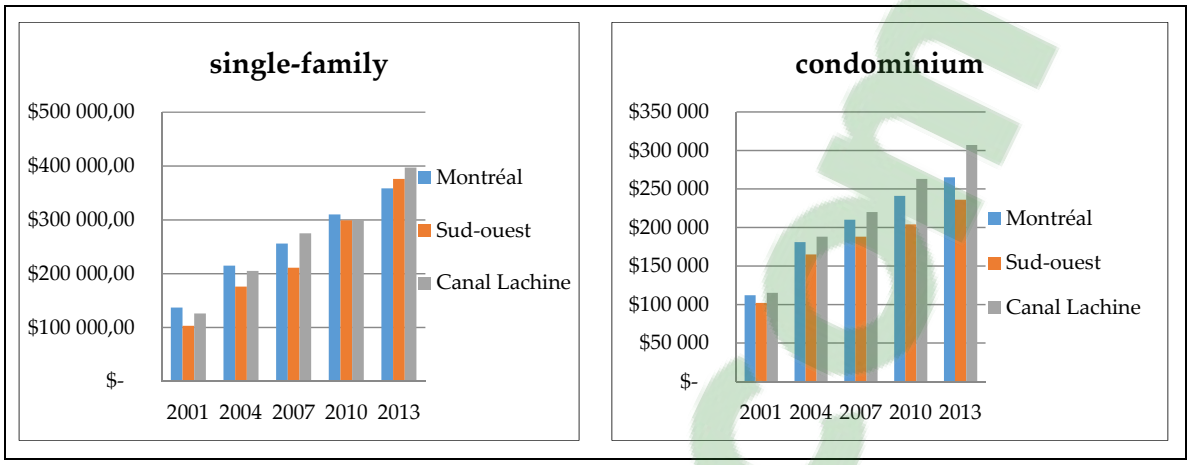

Figure 4-3 Average resale price of single-family and condominium residences

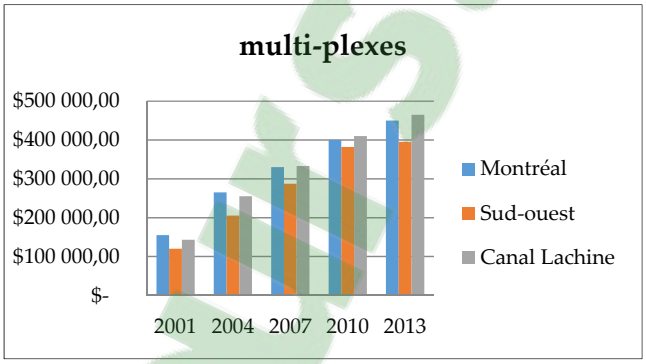

Figure 4-4 Average resale price of multi-plexes

The second part of the second stage is devoted to the construction of graphs for each indicator and their association with neighboring districts. This last step allows the brownfield zone to be compared to other boroughs around the brownfields, as they have the same characteristics of constructions and in the past they were also influenced by the industrial park. The final phase of the case study (third stage) is a comparison of the results with the project goals to assess its performance. First, we calculate the socio-economic indicators using a calculation equation and our analysis of the collected data. We then analyze the results and compare these results with the objectives of the revitalization project. This assessment allows us to verify which objectives were attained and which were not, and to what degree. As Figure 4.5 shows, the average rent increased significantly four years after completion of the first phase of this housing project. The major increase was 165.47%, which

occurred between 2001 and 2006, when the average percentage increase in the borough was only 16.35% for the same period, similar to the increase in the city of Montréal (16.88%).

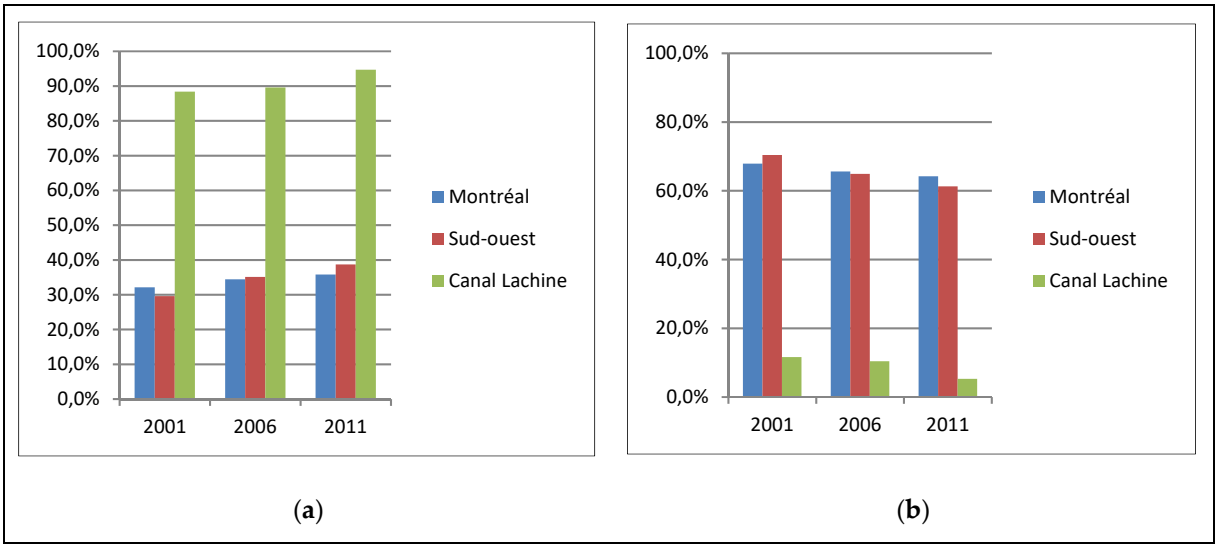

Figure 4-5 The trends of proportions of home ownership (a-left) and rental housing (b-right) during the time period 2001 to 2011

This very high rent increase explains why there are few average-income families in the newly developed site, whereas the objectives (socio-economic benefits, Southwest District Development Plan, 2002—City of Montréal) included finding new solutions for these families. Similarly, we can see that the percentage of owners who live within the former industrial site rose from 89% to about 95% within 10 years. The desired social diversity was clearly not met; not even medium-income people or families had access to a home in this project. In the rest of the Southwest, the rent increases are in line with those of other Canadian cities and especially with the city of Montréal. Rents did not increase significantly in the period 2006–2011, in fact, the 14.68% rent increase in this brownfield development was in line with the borough's 14% (Figure 4.6). However, for the period 2011–2014, the rents increased dramatically in the Canal Lachine post-industrial area, while the percentage of rent increase in the borough was comparably much lower at 6.16% ($1421.00 in the Canal Lachine area compared to $689.00 in the borough overall). In addition, from 2011–2014, the percentage of home ownership has been consistently much higher in this development than in the rest of the district and in the city of Montréal.

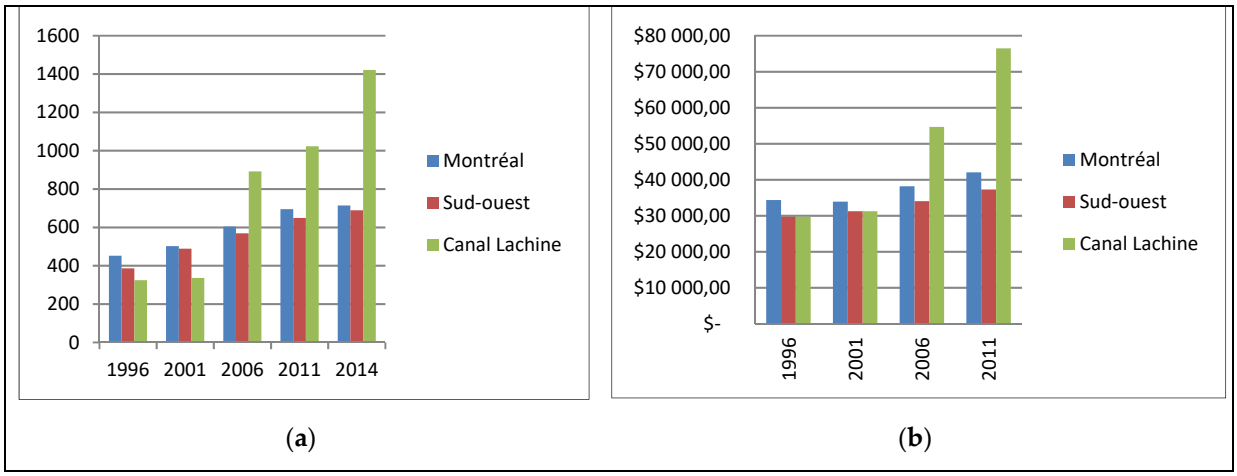

Figure 4-6 Average monthly rent ($) (a-left) and total revenue ($) (b-right) for the time period 1996-2014

4.6 Discussion

We have presented an ex-post evaluation to analyze an urban rehabilitation project. Figure 4.7 indicates the areas of the brownfield Lachine-Petite Bourgogne-Turcot that we took into consideration. It is in these three sectors that we can evaluate the improvements in the rehabilitation of brownfields and realize the complexity of this re-habilitation, because during the interventions we must take into account the context of the site and also to value and preserve those industrial buildings that have historical interest. Through this figure, it can be noted that the brownfield is embedded in the urban fabric of the city of Montréal. This gives us an idea of the transformation and the potentiality that wastelands have on urban development strategies. Given the four indicators calculated and the data presented, it may seem at first sight that some results are contradictory. Indeed, if we analyze the brownfield data on the sale of homes (Figures 4.4 and 4.5) we can note that in the three typologies taken into consideration the selling price is still below the price of the city of Montréal, but above the price of the district. This means that the effect of gentrification has given more value to brownfield buildings without this trend being reflected in the borough. In addition, we analyzed an indicator of the gentrification of the sector, namely, the increase in the number of owner-occupied dwellings, which indicated to us much higher values than in other sectors of the city. In order to support our observations, we observe that the easternmost part of the

Southwest borough is in direct contact with Old Montréal, which has greatly changed since 1996. Economic development initiatives and revitalization halved the number of unused or dilapidated buildings and the vacant lot area there decreased by 20% (RESO, 2002) since 1998.

The data obtained, however, indicates that the average household incomes in the area near the reclaimed brownfield are lower compared to the other boroughs and to other cities. In addition, the gentrification of the Saint-Henri and Turcot sector seems to have influenced both sectors. It is likely that due to the lack of affordable and social housing units and the pressure of some community groups that the local population has not been relocated despite renovations and the rising value of the buildings. A slow and uncontrolled transformation of this environment seems to slow down the relocation of its residents. This explains the importance of having indicators to better manage all phases of project development. In this case, the role of the actors involved in the project development phase is crucial.

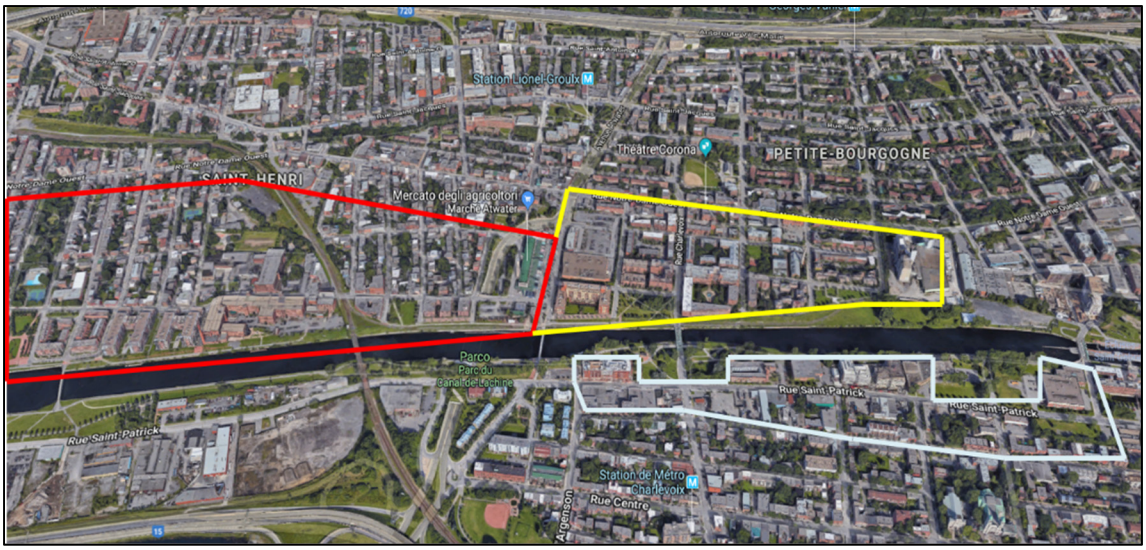

Figure 4-7 - Saint-Henry (red), Petite Bourgogne (yellow) and Turcot (white) sectors

4.7 Proposal for an Evaluation Tool for Decision-Making in Urban Projects

The principal objective of this ex-post analysis is to focus on key economic and social impacts with the aim of improving the process (individuation of actors and the selection and effective use of indicators) rather than to evaluate the effects of a revitalization.

Tableau 4-6 Stakeholder groups involved in a development project's phases

Stakeholder Groups	Public or Private
National policy makers	Politicians National, ministerial, administrative
Local policy makers	City, municipality, community
Institutional and associative players	Urban service companies, associations, social landlord, non-governmental partner, university, managers
Private project management	Investors, promoters, private landlords
Project manager and experts	Consultants, designers, urban planners, sociologists, engineers, bureaus of studies, experts, renovation agencies
Operational players	Companies, private contractors, operators, technicians, artisans
Users	Inhabitants (owner, tenant), residents, employees

Without going into the modality of participation, we can ascertain certain groups of key actors in a sustainable project process. As shown in Table 4.6, there are basically seven groups of actors, attributed according to their level of intervention and according to the hierarchy of their participation in a project, commensurate with their disciplinary function (Cappai, Forgues, & Glaus, 2016).

Studies show that the participation of stakeholder groups in the project phases is essential (Cappai, Forgues, & Glaus, 2016; Sardinia, Craveiro & Milheiras, 2009), but each group of stakeholders must make their specific contribution at certain phases for a successful, sustainable urban redevelopment project. Not confined to rigid categories, but according to criteria that meet each objective of the project and that are linked to the policy makers that

come into play in the subsequent stages of the project, each group should contribute their expertise and provide openings for other actors whose roles are in the later stages. As mentioned in previous studies (Cappai, Forgues, & Glaus, 2016; Chen et al., 2009), this methodology has two levels of participation: Essential and conditional. The first five groups of players in the table are essential, while the last two groups provide a conditional participation in the design and project assessment phases. This approach puts people and their organizations at the center, where they can play a decisive role that can produce new solutions and promote sustainability (Moussiopoulos, 2010; Sharifi and Murayama, 2014; Chang et al., 2012). This group of players can act as a driving force to motivate new political decisions, spur professionals to action, as well as involve citizens directly in a project (Doick et al., 2009; Moussiopoulos, 2010; Luderitz, 2013; Cappuyns & Kessen, 2012; Chrysochoou et al., 2012; Cohen, 2010). The goal of stakeholders should be to select the thematic areas that encompass the dimensions of sustainability required to integrate the project into a neighborhood. In Table 4.7, we offer an inventory of the thematic fields covered by the existing tools, research and field work and incorporated into the following standards LEED-ND, BREEAM Communities, CASBEE-UD, SBTool, Green Star.

Tableau 4-7 Dimension and individual thematic fields in articles

Dimension	**Thematic Field**
Environmental enhancement	Natural resource management (rain water, waste water, alternative energy, etc.), biodiversity, quality of natural areas
	Environmental protection (floods, rivers, lakes, parks, animals, etc.)
	Improved comfort and health (clean-up of the site)
Equitable social enhancement and social responsibility	Strengthening cohesion and social equity (Affordable housing)
	Enhancement of architectural heritage (buildings and materials) and historical (preservation of historical memory)
Economic strategy	Cost reduction
	Increased cohesion (accessibility and transport) and economic activity (jobs and enterprises)
	Multi-functionality of the territory, territorial competitiveness

We also provide a selection and aggregation of the thematic areas that are most often discussed in this field, combined with a selection of those areas that include sustainability aspects to be addressed in a neighborhood project or industrial redevelopment (Table 4.7).

The choices arrived at by following these criteria allow us to rank the thematic fields according to the three dimensions of sustainable development: Environmental, social and cultural, and economic. This proposal of thematic fields is only the first stage of an analytic study of the problems arising from the tools studied. We then converted these three dimensions into eight thematic fields, summarized in Table 4.7. The subsequent phases of our methodological framework complete the selection of indicators for each dimension and thematic scope. What is important, at the moment, is not the detail of the elements (indicators) but to take into account the different dimensions to understand and assess intelligent development and steer it so that it can meet local expectations as much as possible.

4.8 Alignment with Other Theories and Works

Our study allowed us to understand the difficulties that municipalities have in pursuing the objectives of the project and to put into action the expectations of the local community. We have seen that in the redevelopment project of brownfield Canal Lachine-Turcot-Petite Bourgogne, the objectives related to social criteria were partially implemented. The interests of private partners were given priority in the development of housing in brownfields. As a consequence, less affordable housing was neglected and lower income people cannot afford to purchase or rent in brownfields.

Our study is in line with other studies that have been done in this area of the city of Montréal. For example, the study carried out by Préfontaine (2008) on the revitalization of the brownfield has shown a transformation from industrial to residential use may have an impact on the value of properties near the brownfield and therefore on land revenues. Other studies conducted by Mathieu (2011), using socio-economic indicators (improvement of local life and accessibility) have shown that large industrial wastelands are easier to rehabilitate

according to the expectations of the local community, because on a wider scale, transformations can affect economic benefits and/or community lives.

Another study conducted by Félix Gravel (2012) on a brownfield sector of Canal Lachine-Turcot-Petite Bourgogne on the issue of stakeholder participation and interoperability highlighted the problem of communication and interaction between the local community and private actors. He pointed to the difficulty in coordinating the demands of different community groups given their large numbers. He stressed the difficulty of articulating an expert speech with the City while remaining close to the underprivileged population who is his clientele. According to Gravel (2012), it is important that all stakeholders first and foremost interact and bring out the social and economic benefits and implement them. Gravel (2012) proposes that the role of public, private, and community actors in revitalization is a function of the organizational framework in which it operates, but this role must evolve according to the perception of the buzz of the land market and the potential gains in urban projects and the need to integrate local actors.

Mathieu (2011), in his study on urban revitalization, argues that the issue of gentrification interferes with debates about revitalization; but the term takes different meanings and is used with different purposes. Mathieu (2011), in his speech, distinguishes two groups of actors; the promoters and the decision-makers who want to show that their projects participate in the socio-economic dynamism, but for certain promoters and the city it seems that there is a real concern to balance the dynamism socio-economic situation by preserving a social mix.

In summary, revitalization takes on multiple meanings depending on the actors we meet and can affect very local projects such as global and metropolitan dynamics (Chen et al., 2009; Cheng et al., 2011). The majority of respondents, however, expressed the desire to improve the neighborhood, find a balance in urban development, and respect the resident populations.

The role played by community groups in the revitalization of the Canal Lachine-Turcot-Petite Bourgogne shows a diversity of strategies and means implemented. Indeed, we have

shown that a methodological approach allows decision-makers to evaluate a project according to the expectations of the community and the objectives of the project. We have shown that the role of community groups evolves over time and in different situations, even if the purpose of the groups and the organizational parameters play a fundamental role. In the end, this brownfield revitalization analysis shows that the different roles are rather complementary and that gains are ensured if the rehabilitation takes local expectations into account while considering the objectives of sustainability.

4.9 Conclusions

As part of this study, we had the opportunity to have occasional information on the rehabilitation project and compare it to the scale of the entire borough and to the city. Given the major interventions that were undertaken, we wanted to better understand the improvements made and also to determine if the initial objectives that were the basis of these transformations were achieved. We focused the urban rehabilitation analysis on four indicators that gave us an opportunity to assess these improvements in the built environment, in community life, and in the opportunities for citizens, even those with low incomes, to settle in the community. In each of the indicators, the effect on the wasteland was studied and compared to the corresponding objectives. Based on census and statistical data at several scales, we used an ex-post evaluation that allowed us to make interesting comparisons. Our analysis has concentrated on these qualitative analyses and spatial analysis tools. Using our four indicators, we noticed three weak points in the decision-making processes and in the effort to improve brownfields. These three points are (1) the lack of the use of local indicators to measure the benefits to the community; (2) the difficulty of integrating the participation of all stakeholders in the decision-making process; and (3) the lack of the use of an effective methodology that persists in all phases of the project for decision-making and to achieve pre-set objectives.

We have seen, from the statistical data, that the redevelopment project has had a direct influence on the value of the buildings and, therefore, on the rental and sale prices and, thus,

the arrival of high-income households. However, we cannot observe that wasteland rehabilitation has had the same effects close to the site. Socio-economic variables have shown that they change exponentially, but each of the variables is primarily characterized by its connection with other characteristics of the brownfield (environment) as well as by its location (downtown). We also observed that gentrification had a significant effect that is related to the indicators studied. From the results of this case study, we are able to say that brownfield remediation has enormous potential for revitalizing and improving community life and opens up opportunities for thoughtful city planning. However, to have a positive overall impact, brownfield development must be planned with the use of local indicators (contextualization) and the participation of all stakeholders. It is also essential that each actor must intervene in the project phases concerned and throughout its development. Effective methodology and evaluation tools can help all stakeholders in decision-making.

Applied to the Canal Lachine-Turcot-Petite Bourgogne case study, the proposed approach makes it possible to highlight the evolution of the socio-economic characteristics of the revitalization of a brownfield from indicators accessible from the public statistics data. Therefore, the approach can be used in other places or countries because it takes into account the context of the site and the use of local indicators.

In any research related to the quality of the urban environment, it would be interesting to study more sites in order to draw general conclusions. It would also be useful to study in more detail the transformations of the built environment, which makes it possible to better characterize the transformations of an environment. In another order of ideas, it would also be interesting to study certain environmental aspects related to the concept of sustainable development, such as changes to access to services in the most isolated parts of a neighborhood.

In addition, examples of future practical work include the development of a methodological approach that takes into account project objectives and local expectations, using local indicators. The future practical application of the methodological approach needs to be

further developed, tested, and driven by research. The scope of the study could be expanded to include other innovative approaches to project evaluation by using appropriate indicators. A methodology similar to the one presented here could be used to support the analysis of urban improvements.

Author Contributions: Conceptualization, F.C.; Supervision, D.F. and M.G.; Writing—review & editing, F.C. F.C. conceived the project, the main conceptual ideas and the outlines of proof and made numerical calculations for the suggested experiment. D.F. and M.G. developed almost all the technical details and verified the numerical results of the case study. F.C. wrote the manuscript.

Funding: This research received no external funding

Acknowledgments: We thank all the stakeholders who contributed with their knowledge, time, and ideas to this study. We would especially like to acknowledge Gerald André Zion and Maris Pavelson for their incisive comments on the text.

Conflicts of Interest: The authors declare no conflict of interest.

CHAPITRE 5

A METHODOLOGICAL APPROACH FOR EVALUATING BROWNFIELD REDEVELOPMENT PROJECTS

Francesco Cappai[a], Daniel Forgues[b], Mathias Glaus[c]

[a], [b] GRIDD-ÉTS – Département de génie de la Construction, École de Technologie Supérieure, 1100 Notre Dame W, Montréal (QC), Canada H3C 1K3
[c] STEPPE-ÉTS – Département de génie de la Construction École de Technologie Supérieure, 1100 Notre Dame W, Montréal (QC), Canada H3C 1K3

Article publié dans « Urban Science Journal » Avril 2019

5.1 Abstract

In recent decades, municipalities around the world have been developing community policies and seeking to apply them in their cities. They use methods for exchanging information and opinions on decisions, policies, plans and strategies and involve and consult with the community and stakeholders in all aspects of the decision-making process. The application of methods for thoughtful planning has become the goal of policy makers to improve the lives of citizens and stop the expansion of the city into the countryside. The aim of this article is to integrate the notion of sustainability into a methodological approach, taking into account the actors involved in the decision-making phases, the objectives, and the local indicators in an urban redevelopment project (brownfield). Our approach is based on an analysis of 21 articles and on a transversal and cross-cutting view of the interdisciplinary themes of sustainable development by inserting the main actors into decision-making in urban projects and by selecting local indicators. We put in place a methodological approach for the evaluation of urban projects that takes into account local expectations. The goal is to identify and classify the elements that are needed for decision making, including the indicators related to environmental and socio-economic components, in order to develop an effective

evaluation tool. This research contributes to the knowledge of project evaluation tools in the specific context of a city.

Keywords: sustainable building; brownfield; sustainability assessment; subjectivity; adaptability; urban development, decision making planning

5.2 Introduction

In recent decades, the evolution of urban planning has been oriented towards the principles of sustainable development. The urban population has grown rapidly over the past century (US Census Bureau, (World Population), 2015). In addition, demand for land has increased rapidly to meet the needs of the population settling near urban centers (Chen, Hipel et al., 2009). The loss of open space and farmland, climate change, loss of biodiversity and environmental pollution are major issues that must be taken into account in urban planning. The rapid increase in the demand for land has dramatically increased the total value of real estate over the last 40 years (Isaac, 2002 cited by Chen, Hipel et al. 2009). All of these factors force municipalities to take a lead in the planning of cities and their components (EPA, 2018). It is the stakeholders involved in urban policies that have been called upon (and should be called upon, if they have not already) to make strategic decisions in the development of their cities and territory Bartke and Schwarze, 2015).

It is through projects at the local level—sustainable neighborhood development—that the growing number and diversity of these operations reflect the lack of studies on the approaches and development processes specific to this neighborhood scale, as well as on the question of adapting such an approach in each urban context (Cappai et al., 2018). The redevelopment of brownfield sites within urban areas is now considered a sustainable land use (Thomas, 2002). The use of a methodological approach to brownfield redevelopment should be based on an assessment of the existing context, the external context of the site and the use of local indicators (Cappai et al. 2018). This will enable decision-makers to better

identify local expectations in terms of improving social and economic conditions in order to attach citizens to their neighborhood and engage them and improve the development of the neighborhood (Conte, 2016; Pan et al., 2019).

Brownfields have gained the attention of town planners, municipalities and academics because they are spaces that can be used to accomplish multiple sustainability goals. Indeed, economic issues are often highlighted when evaluating the potential conversion of these wastelands. The integration of brownfields into urban planning is a process in which more and more actors are becoming involved, each with their own specific objectives. The actor's interest leads them to consider various rehabilitation strategies and thus, a multitude of possible uses for brownfields. The majority of rehabilitation strategies are often linked to the revival of industrial activity, in which projects are adapted to new high-tech industries and new economic endeavors. Meanwhile, several conversions have been made for the benefit of residential projects and recreational tourism. The replacement of the industrial function often leads to the creation of public or semi-public green spaces aimed at strengthening the social mix of the neighborhoods affected. Brownfields have a great social impact when they are part of a system of open spaces that act to structure the urban form (Sharifi, 2016). Brownfields can reunite neighborhoods previously cut in half, re-creating links, or, on the contrary, constitute buffer zones between differentiated social or functional spaces. It is from this perspective that the redevelopment of brownfields must consider the growth of urban centers, their density and mixed use, whose overall quality meets a comprehensive vision of sustainability (Burnett, 2007). However, a number of parameters are needed to apply the concept of sustainable development if we are to respect the principles of sustainable neighborhoods and take into account the mitigation of the impact of development on the less fortunate (Cappai et al., 2018). Meanwhile, municipal administrations generally focus on the development of its spaces and the potential increase of their tax revenues, whereas ecologists wish to foster more ecological balance and naturalize sites, often to promote the restoration of water courses and thereby reduce the burden on sewer systems. Promoters are interested in devoting land and possibly recycling buildings for market-rate residences, as that could be highly high profitable. The needs and the expectations of the local community are almost

never taken into consideration. It is important to mention that brownfields can be seen as a unique opportunity for municipalities, as these spaces can help to give a local community an identity, and via the consultation process, offer area residents a meaningful voice in sustainability assessment.

We have chosen to develop a methodological approach addressing the complexity of particular local contexts (industrial wastelands), because we believe that it is at this neighborhood scale that we can identify and apply solutions to most of the problems, which we can then expand to a larger scale. These include the contextualization of the site to the rest of the territory, the appropriate filling of vacant spaces, providing desired services to citizens and the issues involved with historical heritage. This approach also encompasses promoting the use of less polluting materials, without forgetting the social mix by including affordable and social housing, as well as schools, parks, commercial spaces, and community centers.

The main objective of our research is to develop a methodological approach for analysis and decision-making. The goal is to identify and classify the elements that are needed for decision making, including the indicators related to environmental and socio-economic components, in order to develop an effective evaluation tool. This article presents the first part of the research to identify the literature for the intervention framework. The three steps of the proposed approach are as follows: (i) Identification of the stakeholders involved in a brownfield redevelopment process and their involvement in the project phases; (ii) identification of the dimensions covered in each study and the association of thematic areas; and (iii) identification and classification of indicators for each dimension. At the end of our analysis, we will propose a list of indicators that can be used in the decision-making phase and in evaluating the success of the project. This classification is the basis for proposing an effective methodological approach for brownfield redevelopment.

5.3 Awareness of brownfield rehabilitation

Recently, the sustainability parameters used by designers and many municipalities have ranged from environmental design to measures of economic and social success, all promising a high quality of life in new urban contexts (Cappai et al., 2018). The multi-faceted benefits of redeveloping brownfield sites have been studied in a number of works, ranging from the specific technical benefits to economic and social advantages.

The World Summit on Sustainable Development (2002) and the Paris Conference on Climate Change (2015) laid the foundation for sustainable improvements in economic development, social development and environmental protection, including work towards reducing the consumption of fossil fuels to mitigate the production of greenhouse gases.

The concept of sustainable development is related to the "carrying capacity" of a territory, now a commonly used sustainability parameter. This parameter, which Wackernagel and Rees (1998) have named the "Ecological Footprint", is the area of land and or water that is needed to meet the resource needs and process the waste generation of a population. This concept also includes the protection of natural resources and habitats, and so the redevelopment of industrial sites can be perceived as meeting these objectives. The redevelopment of brownfield sites is considered sustainable land use (Thomas, 2002). As defined by the US EPA (1992, 2012), brownfields are abandoned industrial sites that are contaminated, vacant, underutilized and harmful to the surrounding environment. Brownfields, as defined by US EPA (2012) and other organizations of several governments, are spaces integrated in the urban fabric, often near the city center of the major agglomerations of industrialized countries. Sometimes brownfields are found in areas outside a city, but adjacent to virgin or arable land, in small communities, and in rural communities. For brownfields within the urban fabric, while they are indeed spaces where there is no true community identity, they very well could be spaces where citizens find part of their identity through history and its urban components in these spaces. Brownfields are often considered a

burden for municipalities that cannot “make them profitable” or otherwise access their potential for reuse.

Until just a few decades ago, brownfields were seen as barriers to a city’s development because of the high cost of decontamination, a major obstacle for landowners and municipalities who had decided to leave these lands abandoned rather than invest in cleaning them up (Wackernagel and Rees, 1998). In addition, the lack of interest in the redevelopment of industrial wasteland was caused by cultural stagnation and underdevelopment of its economy that had kept the population dubious and therefore unable to arouse the interest of investors (Haapio, 2012; Holden, 2013). In another perspective, the absence of rehabilitation projects can be explained by insufficient social or economic demand (Préfontaine, 2008). In addition to the high cost of decontamination, repurposing old buildings can be very costly and requires a major effort to integrate them into the neighboring context. As stated by Sardinha et al. (2013), reconverting a brownfield site must promote the quality of housing as well as the creation of affordable and social housing in order to encourage the investors to take an interest in the rehabilitation of brownfield by the profitability of the project. Nevertheless, contaminated sites have strengths such as space, potential quality of life, and proximity to the city (Pan et al., 2019; Nyerges et al., 2016).

The sheer volume of brownfields around the world is staggering. Just a few examples can help to understand their impact on local economies. There are about 1,000,000 brownfield sites in the United States, and in Canada there are over 23,078 federal sites that are contaminated or likely to be contaminated (Burnett, 2007; Wackernagel and Rees, 1998). The Inventory of Federal Contaminated Sites (IFCS) lists 15,386 sites as closed (Government of Canada, Treasury Board of Canada Secretariat, 2018). Depending on their location, one can imagine the magnitude of the environmental, social and economic benefits that could be realized with their redevelopment. Efforts to reclaim brownfield sites often come from local will and require government actions. The decisions of local actors often favor economic or environment issues rather than social issues. Conflicts arise when the actors involved have different and sometimes very divergent interests. For example, the interests of community

groups may not be in line with to the reconversion of local economies, an industrial revival or with a reorientation towards tourism and recreation. As an example of the divergent groups involved, studies conducted by De Sousa (2003-2006) in Canadian cities have highlighted the importance of private investment because of the high cost of rehabilitating these sites, to the detriment of community interests. Other studies by Adams and Watkins (2002) and Cappai et al. (2018) focus on the need for a methodology to achieve sustainability goals. These studies have shown that, without an adequate methodology, there is a high risk that a project will not meet its original objectives.

A number of studies have considered the need for an effective evaluation tool to improve the lives of the local citizens and to achieve environmental and economic goals. Indeed, there are now several evaluation tools for project lifecycle assessment as well as for decision-making. For example, the US Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED) [21] guidelines have played an important role in addressing the environmental impacts of the construction industry. As of 2015, in U.S. and Canada, more than 40,000,000 government and institutional buildings in the US were LEED certified (USGBC, 2016). Other directives and programs have been developed and utilized in other countries, for example BREGlobal's BREEAM program in U.K., the CASBEE tool in Japan, and the International Initiative for a Sustainable Built Environment (SBTool).

All of these tools, although they have been used by many different organizations and include programs for evaluation at different scales of intervention (including programs for the evaluation of brownfields), are particularly lacking in the use of indicators, as they do not cover all dimensions of sustainability (Sharifi and Murayama, 2013; Cappai et al., 2018). Methods of evaluating the results of brownfield projects are still required, as most of the sustainable evaluation tools are not capable of measuring the effectiveness of urban regeneration projects, and especially of taking into account both the objectives of sustainability and the expectations of the local community (Cappai et al. 2016). In a study conducted by Pan et al. (2016) in the city of Chicago (USA) whose focus was urban development policies and their impacts on ecosystem services at different scales devised a dynamic model of land use. The model developed was used to analyze the shift from a

traditional ecosystem services valuation approach to an approach integrating spatio-temporal dynamics encompassing a range of potential drivers of change that take into account the complexity of the site. The results have been that land-use change impose land restrictions on the growth of the economic sector through a competitive placement and also affect the spatial externality of production (Pan et al., 2019). For example, Hemphill, McGreal and Berry (2004) cited by Wedding (2007) used a method to measure the effectiveness of urban redevelopment projects with sustainability objectives in mind, but that method used parameters that were not focused on brownfields. Bacot and Dell (2006) suggested indicators to measure the viability of government brownfields programs taking into account the environmental and economic dimensions, but neglected to include indicators to assess the livability (e.g., affordable and social housing, and family services) or the ecological performance of new structures. In addition, their system does not assess the success or failure of rehabilitation.

Nyerges (2016) in describing the problems of sustainable urban development, the decision process and the information tools related to the studied area, based his work with a geo-space tool to take into account the points of view of stakeholders to align with the interests at stake to make complex decisions. Indeed, his tool noted that the simultaneous consideration of social, economic, and environmental conditions can help to characterize housing, transport, surface water, and other systems when taking into account the complexity of durability. However, it is important that before making a decision it is necessary to know the impacts of the proposed designs and the target objectives of the management of sustainability, according to the issues of the projects to be pursued (Nyerges et al., 2016).

Other studies have highlighted the problem of involving stakeholders in the decision-making phase. Indeed, decision making is important for the success of a project. For example, in studies on the success of brownfield redevelopment, De Sousa (2006) emphasized decision-making, as he found that the collaboration between stakeholders is often insufficient and sometimes absent. In a study evaluating the redevelopment of a brownfield site in Montreal, Cappai et al. (2018) noted that the stakeholders only evaluated the project in the design

phase. Indeed, that study demonstrated the need to evaluate a project during all of its phases (from design to completion and use). The issue of stakeholder participation is at the heart of researchers because local governments measure their projects in economic or environmental terms, but not in social and cultural terms (Wedding and Crawford-Brown, 2007).

5.3.1 Stakeholder Input into Decision-Making

In the process of project evaluation and decision-making, stakeholder input is fundamental to implementing territorial development policies that follow the principles of sustainability and meet local expectations. In the case of brownfields, the groups of actors that play a central role are usually the landowners, investors (who provide the capital) and developers (who carry out the project). These actors are directly concerned in the development of brownfields because of their financial interests (Mori and Christodoulou, 2012). According to De Sousa (2006), the use of brownfield land for environmental purposes is seldom taken into consideration by investors and landowners, as their main purpose is to maximize the capitalization of these lands; converting them, for example, into a residential development. In most cases, developers are the most influential actors in the development of urban projects because they are focused on the real estate market (Cappai et al., 2016).

The groups of traditional public actors, (elected officials, urban planners, community activists) who have the most competence in the management of local areas, seek to optimize the use of urban spaces to enhance city neighborhoods (preserving built and landscaped heritage), promote economic and social development, limit or even reverse the increasing needs for energy, ensure the health and safety of populations, and finally create a local dynamic around rehabilitation projects (Cappuyns et al., 2012; Beekmans et al., 2015). As plans move forward according to these priorities and the possibly conflicting priorities of developers, academicians and traditional public actors can play the role of attracting and influencing investors (groups of private actors) to create favorable conditions for economic and urban development (Chrysochoou et al., 2012; Rall and Haase, 2011). Normally, public actors are not included in the process of project development, as they are rarely consulted at

the beginning of project planning. Government public actors (at the level of federal, state and local administrations), often engage technicians or sociologists for the subsequent phases, as these professionals may offer improved management of the process and can increase a project's chances of success. Indeed, government public actors generally do not have a solid grasp of the project cycle and so they prefer to engage with consultants, academics, or associations and institutions.

Academic experts occupy an intermedial space, on the one hand part of the project management, on the other hand, open to the greater population, forming an interface between these two groups of actors. They play the roles of translator, smuggler, media messenger and viewscreen (Zimmermann, 2011). According to Sardinha (2013), "public promoters", in addition to official and professional experts, can also solicit and even mobilize "lay experts" (citizens with special experience), building on their practical knowledge acquired from their active participation in the daily life of their neighborhood in proximity to the brownfield. Local actors, including the residents, neighbors, users and other citizens that constitute the "local community", want to improve the quality of life and the state of their urban environment (Cappai et al., 2018). This local community can express and consolidate local expectations through various actions and initiatives to promote conversion strategies and local development. Involving local citizens in the planning of conversion projects is an important factor for the viability of a project, as they can bring their unique experience of the territory, including observations and knowledge to the other stakeholders, thereby creating the conditions for a project that will be good match for the needs of the local population (Cappai et al., 2016; Sardinha et al., 2013).

Stakeholders can contribute to strengthening the project development process and to the implementation of effective urban policies to improve the quality of life of local citizens while improving the economic and environmental conditions of the territory. Stakeholder groups should be able to position themselves to influence urban projects. Local brownfield developments will more likely be successful if they reflect the results of local decision-making consultations that integrate the objectives of all of the relevant stakeholders.

5.4 Proposed Methodological Approach

The analysis is based a selection of 21 articles related to restructuring case studies of North American and European brownfields. A multidisciplinary approach is used to consider the players involved in all phases of the project.

The first part of the research consists of a report on methodological approaches and frameworks; international tools that are completed or under development. The identification of these fundamental elements will identify their roles and their organization in the redevelopment project structure. Our analysis is based on the identification of criteria, targets. and indicators. The objectives are to propose a set of criteria that characterize urban redevelopment projects and to identify the dimensions and stakeholders that will best select and classify the indicators associated with each dimension.

As shown in Figure 5.1, the proposed methodological approach consists of three main steps. All the stakeholders involved in the redevelopment process are identified in the first step.
An inclusive vision of stakeholders will be incorporated, considering a player as any stakeholder group or individual that is directly or indirectly influenced by the redevelopment process (Freeman (1984); Mitchel et al. (1997) cited by Sardinha et al. 2013).

After identifying the stakeholder groups involved in decision-making, these stakeholders are grouped according to the different categories and placed in each stage of the rehabilitation project. We recognize that the interrelationship of stakeholders between project phases must be specific at each stage that connects common stakeholder groups.

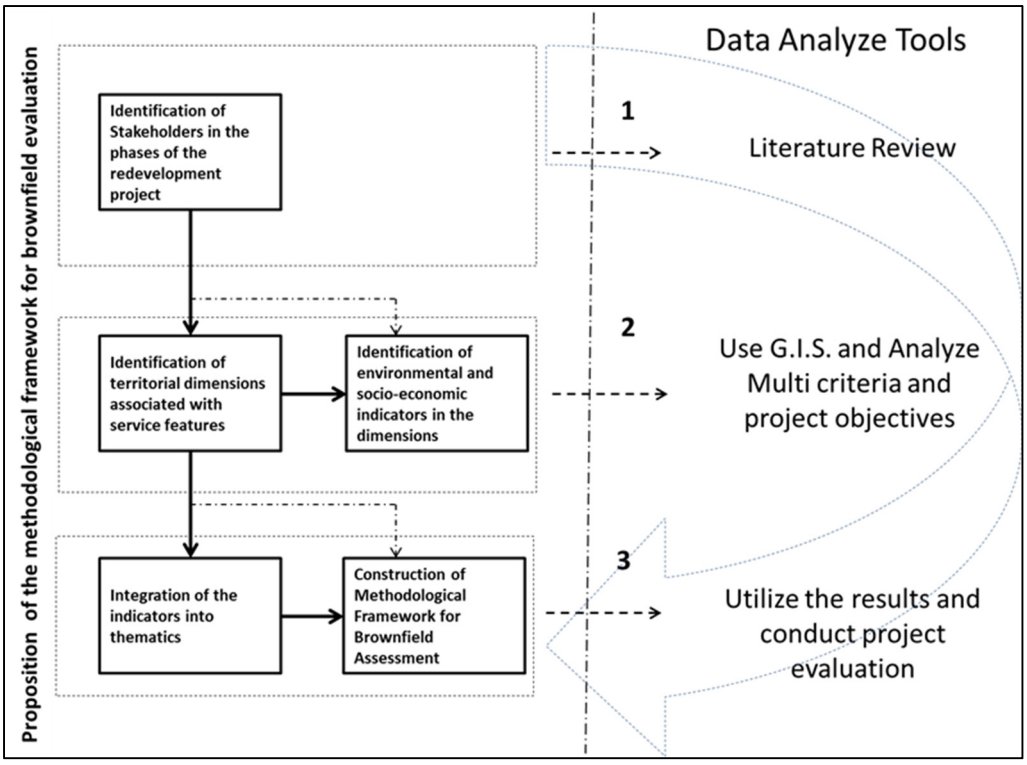

Figure 5-1 Methodological approach for the evaluation project

In the second step, we identify the territorial information associated with the services and at the same time identify the indicators related to the environmental and the socio-economic dimensions.

The indicators for each area are classified, taking into account their interrelations. For example, measures to reduce resource consumption lead to reduced project costs, which are also the result of promoting sustainable lifestyles in terms of consumption. This grouping makes it possible to take into account the links and interdependencies between dimensions and their associated indicators. In this step we use the G.I.S. for the identification of the indicators and a multi-criteria analysis is for the prioritization of the indicators in each dimension that are useful in the evaluation of the project. The use of G.I.S. is focused on territory analysis specifically on brownfields and surrounding areas. It is important to use this tool to identify the territorial dimensions associated with the services functionalities. Similarly, using maps available to municipalities and also through the use of georeferenced

aerial photos. GIS is composed of different layers of geographic reference information. It is a technology that allows you to visualize and analyze data from a geographical perspective, allowing us to view the desired information on a map. In addition, a hierarchical multicriteria analysis (AHP) is applied to synthesize geographic information to select data that responds to priorities and preferences of citizens. This information includes criteria based on territorial characteristics and the location of the functions essential to the quality of life of citizens. This approach is a way to represent the true diversity and distribution of services in a territory.

In the third step, we first integrate the indicators in the thematic fields of sustainable development into the project process by constructing an analysis grid for the characterization of sustainable neighborhoods and then construct a synthetic presentation of the logic of developing sustainable neighborhood projects, based on a cross-tabulation to the application and assessment of the methodological framework. The working method is based on a review of the literature on the approaches in use and the existing evaluation tools. At the beginning of our process, we identify, select, and classify the elements needed for the cross-sectional understanding and characterization of brownfields.

We have been careful to draw the essential phases of a project in general and not to limit ourselves to a specific type of project (renewal, new development, etc.). The actors involved in sustainable neighborhood projects are identified and classified according to several criteria that we will explain later. We base our studies on the subject, on the different proposals of categorization and on organization. The project actors are organized into groups in our classification proposal in order to establish our analysis grid and to identify the environmental and socio-economic indicators in each thematic field. Our work consists of identifying and classifying the thematic fields that encompass all three dimensions of sustainable development. We rely on specific neighborhood level assessment and/or implementation tools and methods, as discussed in the previous section, to develop an inventory of the thematic areas addressed. Finally, we determine the most-representative thematic fields and environmental and socio-economic indicators.

5.4.1 Stakeholders Identification (first step)

Following the literature review (21 relevant articles on brownfield redevelopment) height stakeholder groups were identified. The analysis in these articles led us to reflect on the need for a renewal of the identification of the stakeholders involved in a brownfield redevelopment project. Their involvement was classified based on the respective project phases (Table 5.1). The goal was to identify the level at which each group of stakeholders is involved in decision making. It is in this context that the roles of these stakeholders become more complex and varied. Without going exhaustively into the modality of participation, we can distinguish the groups of key stakeholders in a sustainable project process. As shown in Table 5.1, these actors have been classified into eight groups according to their level of intervention and also in terms of their participation in the project hierarchy according to their discipline. The participation of stakeholder groups in the project phases is essential, but each stakeholder group must contribute specifically at certain phases of a project to achieve a successful sustainable urban redevelopment project. We identified two levels of participation: Essential and conditional. The first five stakeholder groups are classified as essential, while the last three groups are considered to have conditional participation in the design phase and project assessment. This latter classification is given to citizens who had not yet been included in the project phases (Bramley, 2009; Sharifi and Murayama, 2014).

This approach puts people at the centre of decision making and permits them to play a decisive role in the evolution of new solutions and to promote sustainability (Moussiopoulos et al., 2010; Sharifi ans Murayama, 2014). This group of players can be a driving force that not only motivates new policy decisions and the actions of professionals, but who also intervene directly in a project (Moussiopoulos et al., 2010; Doick et al., 2009; Luederitz et al., 2013).

Tableau 5-1 Public and Private Stakeholder Groups

Stakeholders Groups	**Public or Private**
National Policy Makers	National Policy, Ministerial, Administration
Local Policy Makers	City and Community
Institutions and Associations	Urban services, Service companies, Associations, Local housing authorities, Non-governmental partner, Academics, Building managers
Project Sponsors	Investors, Developers, Private landlords
Experts	Urban planners, Engineers, Experts, Renovation agencies
Consultants	Consultants, Consultants designers, Sociologists
Operational actors	Companies, Private contractors, Technicians, Craftsmen
Users	Citizens, Neighbours, Employees

5.4.2 Identification of Dimensions and Thematic Fields and Identification of Indicators in their Dimensions (second step)

In Table 5.2 are listed the 21 items that we considered. Of the 21 selected articles, 13 are based on the three classical dimensions of sustainable development, environmental, social, and economic. Only eight articles stress the importance of adding and evaluating appropriate indicators of socio-cultural dimensions. Addressing only one or two themes is not enough to implement a process for achieving sustainable urban development. As several authors have indicated (Sardinha et al., 2013; Schadler et al., 2011; Doick et al. 2009; Pediatiti et al., 2010), the objectives of sustainability must be addressed in order to achieve an approach that deals with registering a redevelopment project in the urban fabric in a sustainable way (Cappai et al., 2016). We chose a combination of thematic fields, aggregated through an analysis of case studies (see Table 5.3), because we consider it essential to contextualize the urban redevelopment project to the rest of the territory. The results of our analysis highlighted that only a few authors used thematic fields for each dimension; we have

diversified their indicators by placing them in the appropriate thematic fields. Table 4 shows the indicators of each author, classified in their dimensions and thematic fields.

Tableau 5-2 Indicators Found in the 21 Articles Selected

Authors	**and Article Context**
[46]	A Case Study of an Ethnically Mixed Neighbourhood
[7]	Site Prioritization and Selection Process for Brownfield Redevelopment
[19]	Turning brownfields into green space in the City of Toronto
[30]	Measuring -level success in brownfield redevelopments
[2]	Chen, Y., et al.,(2009) - A strategic classification support system for brownfield redevelopment
[44]	Understanding success in the context of brownfield greening projects
[36]	Using GIS to contrast preferred priorities for Brownfield redevelopment
[47]	Pediaditi, Doick, and Moffat (2010) - Monitoring and evaluation practice for brownfield
[42]	Designing sustainable and economically attractive brownfield using an integrated assessment model
[37]	Case Study: A sustainability assessment of an interim use strategy for brownfields in Leipzig, Germany
[48]	Allocating risk capital for a brownfields redevelopment project under hydrogeological and financial uncertainty
[49]	Reversing urban sprawl: A reclaimability index approach for reviving downtown Brownfields
[33]	Evaluation of the environmental impact of Brownfield remediation options: comparison of two life cycle assessment-based evaluation tools
[39]	A sustainability framework for redevelopment of rural brownfields: stakeholder participation at SÃO DOMINGOS mine, Portugal
[4]	No perfect tools: Trade-offs of sustainability principles and user requirements in designing support tools for land-use decisions between greenfields and brownfields
[34]	Countering decline of industrial sites: Do local economic development policies target the neediest places
[50]	An integrative methodology to improve brownfield redevelopment planning in Chinese cities: A case study of Futian, Shenzhen
[8]	The regenerative approach to model an integrated urban-building evaluation method
[26]	Urban Regeneration in Historic Downtown Areas: An Ex-Ante Evaluation in Athens
[51]	A Sustainable Urban Regeneration Strategy for Hong Kong
[52]	Success factors for sustainable urban brownfield development: A comparative case study approach to polluted sites

This analysis includes the following: 1) A comprehensive inventory of sustainability areas covered by the literature, conducted in order to select the thematic fields that are encompassed in the sustainability dimensions used in neighborhood projects and/or in the redevelopment of brownfield projects. This inventory of thematic fields mainly includes the evaluation tools most commonly used by project actors, in research and in the existing fieldwork: LEED-ND, BREEAM Communities, CASBEE-UD, SBTool, and Green Star; it also takes into account 2) a selection and aggregation of the thematic areas most often addressed in these studies; and 3) a selection of criteria including sustainability aspects.

Tableau 5-3 Dimensions and individual thematic fields in the 21 articles

Dimension	**Thematic fields**
Environmental valuation	1) Natural Resource Management (Storm water, sewage, alternative energy, etc.), biodiversity, quality of natural areas
	2) Environmental protection (floodplains, rivers, lakes, parks, wetlands, animals, etc.)
	3) Improved comfort and health (site pollution)
Equitable social value and social responsibility	4) Strengthening cohesion and social equity
	5) Enhancement of the architectural (buildings and materials) and historical heritage (preservation of historical memory)
Economic strategy	6) Cost reduction
	7) Increase of cohesion (accessibility and transportation) and economic dynamics (employment and business)
	8) Multi-functionality of the territory, territorial competitiveness

The choice guided by these criteria thus makes it possible to classify the thematic fields into three dimensions: Environmental, socio-cultural, and economic. Revisiting neighborhood-level assessment systems (such as LEED-ND, BREEAM Communities, CASBEE-UD, SBTool, and Green Star), the 21 articles analyzed and case studies conducted on this topic, revealed that The concept and approaches used in brownfield remediation are evolving to encompass all areas of sustainability and not to introduce more ambiguous and complex indicators, but to introduce levers, linkages and contextualization (Cappai et al., 2018). In addition, although the evaluation tools (LEED, CASBEE, BREEAM, SBTool, and Green star) are well structured, but its indicators are generic and do not evaluate the brownfield in the context where it is located.

In academic work, the main differences between the assessment tools and the methodological approaches analyzed in the literature review tend to be more proactive and positive. They have no specific requirements on how to design or evaluate socio-economic aspects as well as environmental aspects with these indicators (Samset et al., 2017). These approaches and models that we analyzed open a dialogue about the decision-making process but in some cases neglect to focus their attention on the site (Cappai et al., 2018; Bäing et al., 2012; Shen et al., 2012). The application of these approaches depends largely on the context in which they are used and the designers who use them (Cappai et al. 2016). Therefore, the use of these frameworks is limited to the initial phases of the project and they are never used in an ex-post evaluation of the project (Samset et al., 2017). These approaches, as stated (CASBEE-UD, 2018), can complement existing evaluation systems by enabling dialogue, reflection and learning, by integrating the specificity of places and contexts, in particular the benefits that a redevelopment of wastelands have on the ground. environment and the city (Cappai et al. 2018; Pan et al., 2019; Nyerges et al., 2016). The choice guided by these criteria makes it possible to classify the thematic areas in three dimensions: Environmental, socio-cultural, and economic. These three dimensions are then translated into eight thematic fields, summarized in Table 5.3.

The research considers a selection related to the restructuring of case studies of North American and European brownfields. Table 5.4 provides a detailed description of the indicators used in each case study and the objectives identified for each project. By analysing Table 4, it can be observed that the number of indicators considered is different for each author in each thematic field.

To identify and classify the most relevant indicators in brownfield redevelopment projects, the Geographical Information System (GIS) and multi-criteria analysis for the prioritization of indicators in each thematic field were used. The GIS was used to identify indicators associated with their territory that are useful for assessing the context of a site and its surroundings.

As shown in Figure 5.2, the use of G.I.S. has consisted in selecting services all inside the brownfield and also in its surroundings. In this phase the use of G.I.S. was used to select the functions of the services related to the territory. In this way we will identify the indicators that are in relation with the neighboring territory to better contextualize the project to the territory.

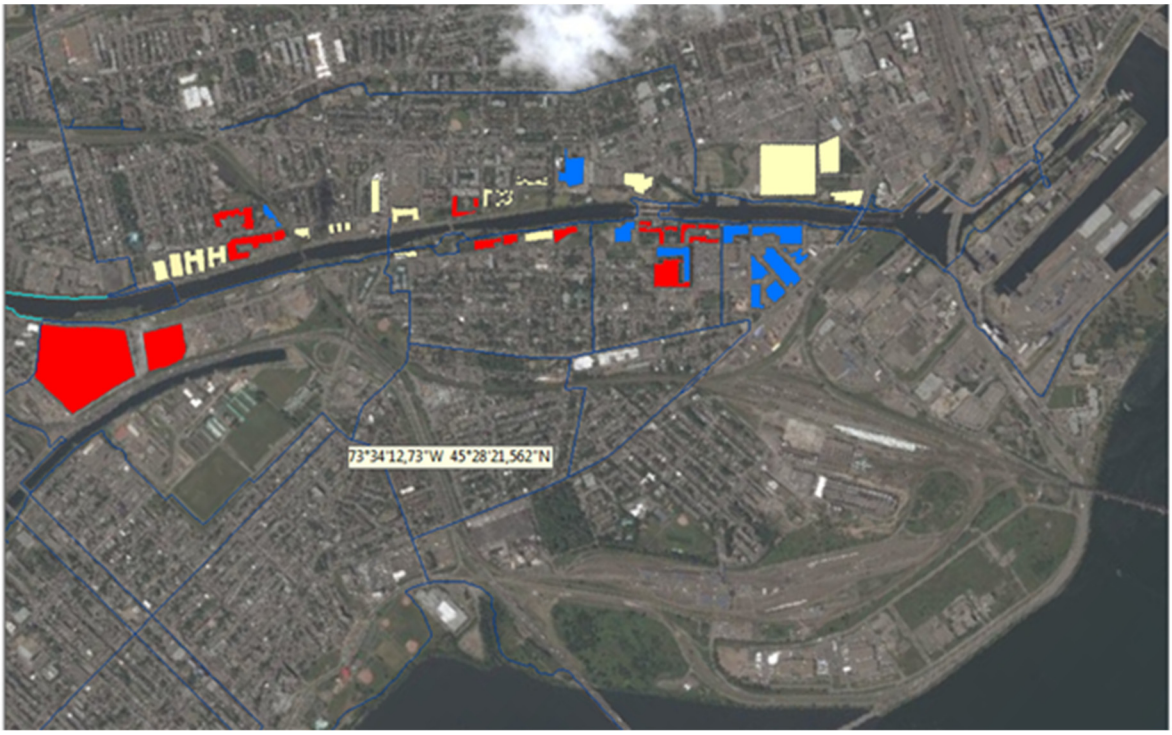

Figure 5-2 Use of G.I.S. in the Brownfield Lachine Canal (Montréal, Canada). Legend: In red the industrial buildings; in yellow the new constructions and in blue the historical building and the blue lines the bicycle paths.

As shown in Table 5.4, we used the thematic fields of Table 5.3 and associated the indicators identified in the analysis of the studies considered with one or more of the eight fields. The first column refers to the source of reference (Author) where each indicator was found. The analysis highlighted that authors who use a high number of indicators are those who diversify them into multiple thematic fields. The other indicators from the literature and evaluation tools were categorized and prioritized using the Analytic Hierarchy Process (AHP). In this way we could weigh the indicators by assigning a weight to each according to its importance (for example, the number of times it is used in the literature).

Tableau 5-4 Indicators found in the literature

Author	Number of indicators							
	Environmental			Social and Cultural		Economy		
	Thematic field 1	Thematic field 2	Thematic field 3	Thematic field 4	Thematic field 5	Thematic field 6	Thematic field 7	Thematic field 8
(Greenberg & Lewis, 2000)	1			8		5		
(Thomas, 2002)	4	4	5	3	5	3	3	3
(De Sousa, 2003)	6	4	7	12	9	5	4	4
(Wedding & Crawford-Brown, 2007)	2	2	6	9	11	3	4	3
(Chen, Hipel, Kilgour, & Zhu, 2009)	1			1		9		
(Doick, Sellers, Castan-Broto, & Silverthorne, 2009)	9			12	4	8		
(Brill, 2009)	2			6		3		
(Pediaditi et al., 2010)	5			5		5		
(Schädler, Morio, Bartke, Rohr-Zänker, & Finkel, 2011)	8	3	3	11	7	4	2	2
(Chrysochoou et al., 2011)	9			5		8		
(Cappuyns & Kessen, 2012)	7			6		1		
(Sardinha et al., 2013)	5			4		3		
(Bartke & Schwarze, 2015)	4	2	2	5	6	3	2	2

Tableau 5.4 Indicators found in the literature (suite)

Author	Number of indicators							
	Environmental			Social and Cultural		Economy		
	Thematic field 1	Thematic field 2	Thematic field 3	Thematic field 4	Thematic field 5	Thematic field 6	Thematic field 7	Thematic field 8
(Beekmans et al., 2015)	4			4		9		
(Cappai, Forgues, & Glaus, 2018)	7	6	5	9	9	4	11	9

The final list of indicators will be used in the methodological approach we propose in Section 5. We assigned a weight of 1 to each indicator that was quoted at least 16 times and more, 0.75 if quoted at least 11, 0.5 if cited six times or more, and 0.25 if indicator have been cited less than six times. In Table 5.5 the weight assigned based to indicator frequency. After assigning a weight to each indicator before integrating them into our methodological approach, we perform a peer comparison for prioritization using hierarchical multi-criteria analysis (AHP), categorizing them in order of their importance (see Table 5.6).

Tableau 5-5 Weight assigned based to frequency indicator

Range				
Number citations indicators In the literature and assessment tools	≤ 5	$6 \leq 10$	$11 \leq 15$	≥ 16
Weight assigned	0.25	0.50	0.75	1

Tableau 5-6 Selected redevelopment indicators and their assigned weights

Indicators	Weight	Indicators	Weight
Infrastructure system water;	1	Accessibility;	1
Water consumption (including water quality) (m^3);	1	Public spaces;	1
Energy consumption (Kwh);	1	Inclusion;	1
Green spaces (Km^2);	1	Security;	1
Water surface (Quality);	1	Urban frame (density);	1
Vegetation (Type)	0.5	Public areas (Parks, living areas);	1
Use of space; Living areas;	1	Diversity (religion, income, race);	0.75
Landscape (unnatural barrier, bridges, viaducts);	1	Population density (person/ha);	1
Enhancing biodiversity;	0.5	Marginal Green (ha/street km);	0.25
Morphology;	0.5	House Diversity (Number of each Type of House);	0.75
River system (Km)	0.5	Land Use Diversity;	1
Ventilation;	0.5	Politics inquiries (Number);	1
Physical comfort;	0.5	Crimes (Number)	1
Proportion of own sites;	0.5	Structure;	0.5
Soil quality (% of contaminants);	1	Materials;	0.75
Lighting (orientation);	1	Technology;	0.75
Heat islands (UHI) (°C)	1	Care and maintenance;	1
Waste management;	1	Form;	0.5
Distribution functions (Number for Area);	1	Architectural fragmentation;	0.5
Service – Business (Number);	1	Architectural quality	
Contiguity;	0.5		
Distance to primary school (km);	1		
Distance to high school (km);	1		
Distance to mosque (km);	0.25		
Distance to catholic church (km);	0.25		
Distance to Anglican church (km);	0.25		
Distance to health center (km);	1		
Distance to airport (km)	0.75		
Streets network;	1		
Public transport (Frequency);	1		
Fluidity of movement (Number O/D);	1		
Parking (Number and Type);	1		
Links, connections;	1		
Economic diversification;	0.75		
Number of jobs (Number);	0.75		
Job Type (Number);	0.5		
Total income ($);	1		
Connections (Type and Number);	1		
Partition areas (m^2);	0.25		
Urban form (urban fabric);	0.75		
Public areas (Km^2);	1		
Historical activities (N. h.a./Job type)			

5.4.3 Classification and Integration of Indicators in a Methodological Framework (Third Step)

In this step, we integrate the indicators selected in the previous step in each dimension and thematic area and then build the methodological approach that we will explain in Section 5. Table 5.7 summarizes the selected and classified indicators in each dimension.

Tableau 5-7 Redevelopment indicators integrated in each dimension

Dimension	Indicators
Environmental	Infrastructure system water; Water consumption (including water quality) (m^3);Energy consumption (Kwh); Green spaces (Km^2); Water surface (Quality); Vegetation (Type) Use of space; Living areas; Landscape (unnatural barrier, bridges, viaducts); Enhancing biodiversity; Morphology; River system (Km) Ventilation; Physical comfort; Proportion of own sites owned; Soil quality; Lighting (orientation); Heat islands (UHI) (°C)
Social and cultural	Accessibility; Public spaces; Inclusion; Security; Urban framework (density); Public areas (Parks, living areas); Diversity (religion, income, race); Population density (person/ha); Marginal Green (ha/street km); House Diversity (Number of each Type of House); Land Use Diversity; Politics inquiries (Number); Crimes (Number) Structure; Materials; Technology; Care and maintenance; Form; Architectural fragmentation; Architectural quality
Economic	Waste management; Distribution functions; Service – Business; Contiguity; Distance to primary school (km); Distance to high school (km); Distance to mosque (km); Distance to catholic church (km); Distance to Anglican church (km); Distance to health center (km); Distance to airport (km) Streets network; Public transport; Fluidity of movement; Parking; Links, connections; Economic diversification; Number of jobs; Job types (Number); Total income ($/household); Connections; Partition areas; Urban form (urban fabric); Public areas; Historical activities (N. h.a./Job type)

The list of actions presented here integrated in Table 5.10 are those that according to the analysis made have priority and must be taken into consideration (Natural Resource Management, Biodiversity, Quality of natural areas, Environmental protection, Improved comfort and health, Strengthening cohesion and social equity, Enhancement of the architectural and historical heritage, Cost reduction, Increase of cohesion and economic dynamics, Multi-functionality of the territory, Territorial competitiveness). These redevelopment indicators taken into account are balanced in the three dimensions (environmental, social, and economic) because they evaluate the particularity of the site, but also the context where this site is and this is important if we want to build sustainable neighborhoods.

5.5 Construction of the methodological approach (Analysis Results)

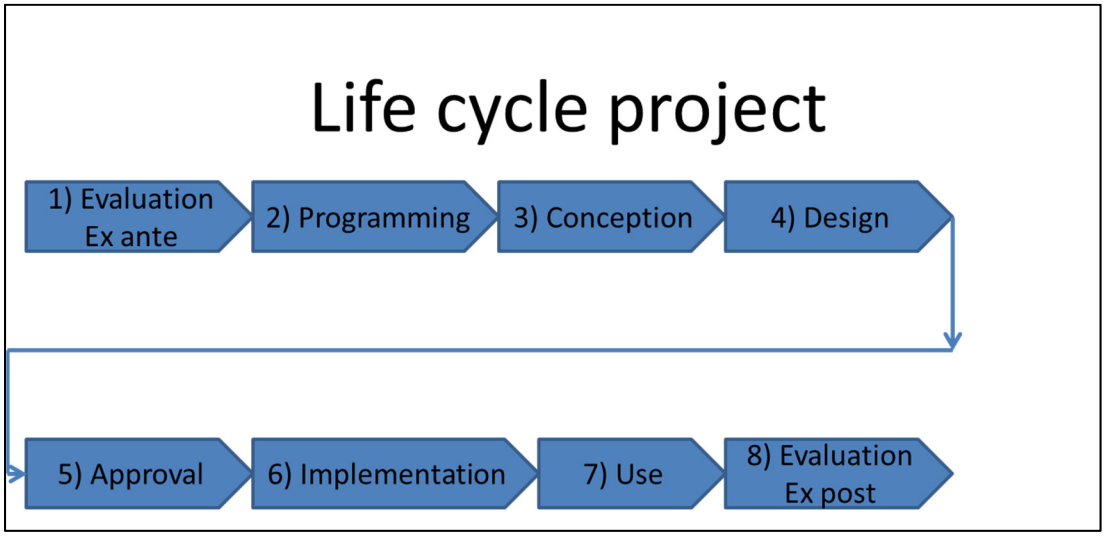

Figure 5-3 The phases of an urban redevelopment project
(Régie du bâtiment Québec, 2013 – the processis designed by authors)

The redevelopment project of a territory structures its organization according to the stages of a construction project in general. The difference is that a brownfield redevelopment project has to take into account its past (land use), all the existing buildings (reuse and cultural interest) and the contextualization scale (urban or rural extra urban), along with the

associated environmental issues. In our proposal, the urban redevelopment project is based on the same stages of the life cycle of a construction project.

This perspective allowed us to include some fundamental steps in the life cycle of a project. Our proposal emphasizes that certain steps must be well-identified in order to achieve the expected goals at the end of the project. Figure 5.3 indicates the basic steps of a redevelopment project. It is clear that this scheme can be applied to any kind of urban project.

We propose that the stakeholder groups we have identified must be involved in urban redevelopment projects. We classified the actors into eight groups (Table 5.8). These stakeholder groups are each involved in a different way at each stage of a project. With the identification of the actors involved at each phase, their roles and the governance logic of the project can be detailed.

Tableau 5-8 Involvement of stakeholder groups in a project's phases

Stakeholders Groups	**Ex ante**	**Programming**	**Conception**	**Design**	**Approval**	**Implementation**	**Use**	**Ex post**
National policy makers		X			X			
Local policy makers	X	X	X		X	X		X
Institutions and associations		X		X	X	X	X	X
Project Sponsors		X		X				
Experts		X		X				X
Consultants	X			X				X
Operational actors			X			X		
Users	X			X	X	X	X	

5.5.1 Identification Indicators and Stakeholders' Positioning

Our methodological approach is inspired by the analysis of the decision support tools found in selected articles that take into account economic, social and environmental aspects. All of the approaches incorporate the fundamental issues of a project, including the definition of the objectives and indicators related to its urban scale (Table 5.9).

Tableau 5-9 Positioning of stakeholder groups in the dimensions and life cycle a project

Life Cycle Project	**DIMENSIONS**							
	ENVIRONMENTAL			**SOCIAL**		**ECONOMIC**		
	Thematic Env. 1	Thematic Env. 2	Thematic Env. 3	Thematic Soc. 4	Thematic Soc. 5	Thematic Eco. 6	Thematic Eco. 7	Thematic Eco. 8
Ex Ante Evaluation	①	①②	①		①②	①		①②
Programming	①②⑤	①②⑤	①⑤	②⑤⑦	②	②	②	②
Conception	②③⑤⑥	②③⑤⑥⑦⑧	②	③②④⑤⑥⑧	②⑧	④	④	②
Design	③④⑤⑥	③④⑤⑥	③④⑤⑥	③⑤⑥	④⑤⑥	③④⑤⑥	⑤⑥	③④⑤⑥
Approval	②③⑤⑥⑦	②③⑤⑥⑦	②③④⑤⑥⑦	②③④⑤⑥	②③⑤⑥	④⑦		②
Implementation	②③④⑤⑥⑦	②③④⑤⑥⑦	②③④⑤⑥⑦	②③④⑤⑥	②③⑤⑥	④⑦		②
Use	②⑧⑤⑥	⑤⑥	⑤⑥	⑧	⑧			
Ex Post Evaluation	②⑤⑥	⑤⑥	⑤⑥	②⑤⑥	②⑤⑥	⑤⑥	②⑤⑥	②⑤⑥

Legend: ① National policy makers; ② Local policy makers; ③ Institutions/Associations; ④ Project Sponsors; ⑤ Experts; ⑥ Consultants; ⑦ Operational actors; ⑧ Users

Most of the tools and approaches we found are focused on the environmental and social aspects of urban spaces, while our study is more oriented towards the integration of sustainability in a brownfield redevelopment project (socio-economic aspects) in an urban context (neighbourhood).

However, this method does allow us to build an approach in the formulation of a project's issues and criteria. As a first step, the methodological approach is based on the thematic fields identified for each dimension, and then on the actions to be taken. This is interpreted on three levels: the thematic fields are first translated into actions to be carried out in general and then into objectives, and finally into parameters to be addressed. The implementation of these actions and themes comes from an analysis of the existing tools, data, and information collected.

To better organize all the data collected to date, we assembled selected stakeholder groups with their dimensions in order to understand how these groups of actors intervene during the life cycle of an urban redevelopment project. Analyzing Table 9 allows us to understand how the actors are involved during the decision-making process and in the definition of a project's objectives.

5.5.2 Integration of Indicators into Dimensions

The indicator integration process is based on the following considerations:

- Inventory of the (territorial) dimensions and actions, parameters or indicators most often mentioned;
- Eliminate any redundancies of repeated items; and Compare themes with studies to identify those with the similar direction (scale, context, etc.).

The dimensions were then presented within hierarchical structures (according to the traditional dimensions of sustainable development), in the form of the actions to be

undertaken for each thematic field and the themes to be addressed (the targets of these actions). Then, we identify the parameters to be evaluated. After identifying the three factors (processes, actors, thematic fields) structuring the projects of sustainable neighborhood, we put them into perspective by developing an analysis grid.

Tableau 5-10 Redevelopment settings

Actions	**Indicators**
Natural Resource Management (Storm water, sewage, alternative energy, etc.), biodiversity, quality of natural areas	Infrastructure system water; Water consumption (including water quality) (m^3);Energy consumption (Kwq); Green spaces (Km^2); Water surface (Quality); Vegetation (Type) Use of space; Living areas; Landscape (unnatural barrier, bridges, viaducts); Enhancing biodiversity; Morphology; River system (Km) Ventilation; Physical comfort; Proportion of own sites owned; Soil quality; Lighting (orientation); Heat islands (UHI) (°C)
Environmental protection (floodplains, rivers, lakes, wetlands, parks, animals, etc.)	
Improved comfort and health (pollution of the site)	
Strengthening cohesion and social equity	Accessibility; Public spaces; Inclusion; Security; Urban framework (density); Public areas (Parks, living areas); Diversity (religion, income, race); Population density (person/ha); Marginal Green (ha/street km); House Diversity (Number of each Type of House); Land Use Diversity; Politics inquiries (Number); Crimes (Number) Structure; Materials; Technology; Care and maintenance; Form; Architectural fragmentation; Architectural quality
Enhancement of the architectural (buildings and materials) and historical (preservation of historical memory) heritage	
Cost reduction	Waste management; Distribution functions; Service – Business; Contiguity; Distance to primary school (km); Distance to high school (km); Distance to mosque (km); Distance to catholic church (km); Distance to Anglican church (km); Distance to health center (km); Distance to airport (km) Streets network; Public transport; Fluidity of movement; Parking; Links, connections; Economic diversification; Number of jobs; Job types (Number); Total income ($/household); Connections; Partition areas; Urban form (urban fabric); Public areas; Historical activities (N. h.a./Job type)
Increase of cohesion (accessibility and transportation) and economic dynamics (employment and business)	
Multi-functionality of the territory, territorial competitiveness	

The grid is an interface for integrating thematic fields of sustainable development into the project process. The objective is to position and relate the problems and the essential factors identified in a global and complex vision to characterize a project of urban revitalization.

The purpose of this approach is to establish the level of complexity of the problem as well as to form a structure of the criteria with which to establish the actions to be taken to achieve the redevelopment. To integrate the aspects of sustainable urban development, the dimensions are cross-linked with the project's parameters to translate the objectives for a project's development. The thematic fields are then selected from this crossing to identify the most-important issues to consider for successful integration (see Table 5.7).

It is assumed that between the themes and phases of project design there are links to arrive at intelligent redevelopment objectives. For example, architectural heritage enhancement is related to urban form and to the historic preservation of buildings. There is also a link to the multi-functionality of services, the use of the territory and the social relations of citizens and economic activity at the industrial site. The proposed approach aims to contribute to brownfield redevelopment by transforming the traditional project criteria to support a sustainable redevelopment approach in which stakeholders use these criteria as the basis of communication with other stakeholders.

The list of criteria is based on two groups of data. All of the themes proposed for sustainable redevelopment earlier in our analysis were expressed as a set of criteria for the design of a sustainable brownfield redevelopment. In practice, by crossing each theme with each parameter we were able to establish the integration criteria. This was done with the intention to collect and consolidate criteria that meet different objectives with the parameters of design, as well as to assemble the same practical criteria. Table 5.11 shows the linking of actions with the parameters of the redevelopment setting (indicators).

5.6 Discussion

Thus far, the study has only revealed partial results, as there is not much specific literature that considers the tangible socio-economic aspects in brownfield development. Most studies that consider environmental issues prioritize soil contamination and decontamination. New criteria are essential for sustainable development solutions, and for brownfield rehabilitation. The tools used by professionals and municipalities have their shortcomings in terms of project evaluation. A tool must be able to clearly identify a project's objectives, and to classify and prioritize them based on local interests. The need for regeneration of the natural environment, including the landscape and biodiversity should be a priority (Schadler et al., 2011; Bäing et al., 2012).

As Pan det al. (2019) affirms, traditional methods of urban rehabilitation and land use neglect socio-economic causes. It is clear to us that without the inclusion of feedback to remove uncertainties, such an approach could significantly underestimate the resulting impacts on ecosystem services (Pan et al., 2019; Nyerges et al., 2016). Therefore, considering this aspect, it is necessary to build a dynamic and retroactive method that integrates human activities and environmental processes into decision-making (Pan et al., 2019) in order to assess their impacts. Socio-economic and environmental processes to build local indicators that better assess the territory (Cappai et al., 2018).

The quality of brownfield conversion is related to meeting users' expectations for the rehabilitation of these sites. This can be attained through the use of suitable indicators. As stated by Willians and Dair (2007) and Ballesteros and Ramirez (2007), cited in Sardinha et al. (2013), attachment to cultural heritage must be among the objectives of redevelopment projects because of the influence of the concepts of landscape and the social aspects of the community. The indicators related to the conditions of public safety, accessibility, etc., also need to be part of the redevelopment of brownfields (Schadler et al., 2011; Pediatiti et al., 2010; Bäing et al., 2012; Thomas, 2003). A new methodological framework characterized by

a multi-criteria, transversal, and comprehensive approach is a requirement for moving towards sustainable redevelopment.

5.6.1 Alignment with Other Theories and Works

Our methodological approach is in line with other studies that have touched on the problem of sustainable neighborhood development and the evaluation of sustainability. One example is Sharifi and Murayama (2014), who identified some of the shortcomings in the most commonly-used evaluation tools in their neighborhood sustainability studies.Their work highlighted the need for a methodological approach to co-evolve and optimize decision-making, as well as to optimize existing tools.

Another study, conducted by Haapio (2011) and focused on decision-making and the importance of a methodological approach, found that evaluation tools and systems (BREEAM Communities and LEED) are increasingly used by investors, promoters and real estate developers to support their projects from an economical perspective. Haapio observed that the tools need improvement, especially in terms of their indicators, and that they should be used for decision-making. His study concludes by with a call for a methodological approach, where the participation of authorities, planners and designers will help improve the process of decision-making, especially in an urban context.
Mori and Christodoulou (2012) focused on the development of a methodological approach for the evaluation of cities and the use of local indicators. They showed how in a valid sustainability evaluation, it is imperative to take into account environmental factors and economic and social aspects (the triple objectives of sustainability). They also affirm the need to create indices/indicators capable of evaluating the world's cities in developed and developing countries by using common lines of assessment.

An earlier work conducted by Moussiopoulos et al. (2010) focused on the use of indicators to assess the sustainability of cities in a case study on the metropolitan area of Thessaloniki in Greece, they argue that measuring sustainability in urban areas is a major challenge for

managers and decision-makers. They aimed to develop and use a system of indicators for the management of environmental, social, and economic information to assess sustainability in urban areas, thereby improving the communication between stakeholders in the development process of development.

In summary, it is clear that the roles played by community groups and other decision-makers indicate that there are a variety of strategies for implementing the sustainability assessment. Indeed, we have been able to show that a community approach allowing actors to carry out a joint evaluation of a project is desirable. We have shown that the roles of stakeholder groups evolve over time and in different phases of the project life cycle. It is the communication between them that can set up an effective methodological evaluation method. In the end, we can say that the different roles can actually be rather complementary, and that the active participation of all of the stakeholder groups will undoubtedly promote sustainability in urban contexts.

5.7 Conclusions and Future Work

The sustainable development approach has led to a renewal of the conceptual issues of project development. The new criteria resulting from the crossing of thematic issues with the parameters of project design allow for better control of a project's implementation. These improvements are especially notable in the early stages of programming and project design. However, it is interesting to note that the success of such an approach in the context of a development project depends on the contributions of all of a project's stakeholders, and not only on national and local policy makers. What we can say is that each stakeholder group involved in the decision-making process must contribute by interacting with other decision-makers. Local and federal public actors must seek to compensate for investors' economic interests and local expectations. It is clear that economic interests should also be favored if we want the external supply of capital, but investors must also propose and leave room for social objectives by seeking to bring the resilience of their projects in an urban sustainable context. Roundtables and interviews in all phases of the project cycle will be useful for

pursuing sustainable development goals and improving debate among all stakeholders. This is clearly demonstrated in the results of our crossing the thematic issues with project parameters: project development criteria fail to address several of the issues that are required for a successful urban redevelopment. Another consideration is the use of evaluation tools and the models used by stakeholders, as they have gaps in their structure. All the models concur that all three sustainability dimensions should be covered and that the social and environmental aspects should have greater amplitude, especially when planning brownfield developments. The tools assessed here are not able to adequately assess all three dimensions. Some indicators are related to urban forms but are not treated with the appropriate tools. Another observation is that the number of indicators becomes fewer representatives in some studies, and that project objectives sometimes take the place of indicators.

This study allows us to see the shortcomings of the tools used by professionals and municipalities, deduced from the intersection of the themes and indicators of the tools used in the case studies. The results of the analysis demonstrated that the methodological approach is structured to be used in different contexts. However, even if it is rigorously built, it is not without limits. One of the limits is that its structure can appear complex in the step of identifying the thematic fields and thus in the integration of the indicators. But, if we are able to differentiate the indicators in the early steps, the work should be less overwhelming. We plan to validate the methodological approach in case studies, and to use it in the early stages of a project's life cycle to allow for improvements if they are identified. We prefer to leave the methodology open to supplementary and continuous evolutions, as this methodology will require checks and balances to validate the developed tools.

Acknowledgments: The authors would like to express their appreciation for two laboratories of the École de Technologie Supérieure—GRIDD and STEPPE—for their financial support in conducting this study. Thanks should also go to all of the experts we consulted for their time and input during the realization of this article. Finally, much gratitude is extended to two anonymous reviewers for their valuable comments on this paper.

Author Contributions: Francesco Cappai conceived the project, the main conceptual ideas and the outlines of proof and made numerical calculations for the suggested experiment. Daniel Forgues and Mathias Glaus developed almost all the technical details and verified the numerical results of the case study. Francesco Cappai wrote the manuscript.

Conflicts of Interest: The authors declare no conflict of interest.

CHAPITRE 6

DISCUSSION

La démarche que nous avons proposée à titre exploratoire vise à un rapprochement et à une mise en dialogue de tous les acteurs impliqués dans le cycle de vie d'un projet de réhabilitation urbaine, suivant une démarche interdisciplinaire. Les études de cas présentés dans le troisième et le quatrième chapitre visent à opérer un rapprochement entre les questions d'évaluation et de représentation spatiale, ils permettent de saisir les enjeux et de faire face aux limites des méthodes actuelles et des outils utilisés.

Cette recherche s'est intéressée au développement d'une méthode d'évaluation environnementale pour l'intégration de la notion de durabilité dans les projets de réhabilitation des friches industrielles. Pour cela, nous avons mis en place une grille des indicateurs locaux intégrés aux thématiques communes de la durabilité avec les problématiques de la réhabilitation des friches industrielles en termes de la prise de décision, (participation des acteurs impliqués) d'évaluation du projet (cycle de vie du projet et indicateurs locaux) afin de trouver les propositions en termes d'élaboration d'une méthode d'évaluation environnementale.

D'un point de vue opérationnel, dans la mesure où les friches industrielles sont par nature situées, leur évaluation doit rester contextuelle et s'appuyer dans la mesure du possible sur une connaissance des enjeux et des objectifs du projet et des connaissances locales. La démarche méthodologique doit prendre en compte les usages passés et leurs conflits actuels (pollution des terrains, bâtiments existants, etc.) avec le reste du territoire. L'enjeu de la méthode proposée est de produire une valorisation consensuelle partagée par les différents acteurs impliqués, et de parvenir à faire dialoguer et rendre efficaces les enjeux économiques, sociaux et environnementaux du territoire.

Nos études de cas réalisées dans la friche industrielle et dans les arrondissements de la ville de Montréal indiquent que la plupart des outils d'évaluation doivent être révisés car la plupart n'incluent pas les aspects socio-économiques. Nous avons démontré que l'application de l'outil d'évaluation CASBEE-UD intégré avec des aspects socioéconomiques peut permettre de mesurer le succès en tenant compte des objectifs du développement durable. En effet, un outil d'évaluation doit prendre en compte multiples aspects, notamment: (i) la disponibilité des ressources, (ii) la viabilité économique et (iii) l'acceptation sociale. L'utilisation de notre méthode nous a permis d'apprécier la contribution de l'utilisation d'indicateurs locaux. En plus, la méthode proposée a attribué une note positive à l'efficacité environnementale basée sur les indicateurs environnementaux, mais ce qui nous a le plus intéressé, est que cet outil d'évaluation peut être appliqué à des contextes différents.

La stratégie de recherche a été guidée par :

- Un refus d'approches trop simplistes et la volonté de restituer au mieux ces espaces inutilisés à la ville, par un regard à la fois transversal et en même temps en insérant des questionnements propres à la conduite de la prise de décision et d'évaluation du projet.
- Le recours à des approches systémiques favorisant « l'analyse multicritère », à des outils pour l'évaluation spatiale « SIG » et à l'utilisation de l'analyse statistique.

Cette recherche est tournée vers des enjeux concrets de gestion ou de régulation des usages. Elle s'appuie sur une analyse des enjeux territoriaux et aussi s'appuie sur l'utilisation de l'analyse multicritère et du Système d'information géographique. De plus, l'analyse spatiale basée sur les SIG permet d'identifier le cadre bâti existant et d'intervenir avec une planification stratégique efficace en mettant les interrelations entre les quartiers avoisinants. La méthode que nous avons proposée a permis d'identifier les champs thématiques clés et les domaines d'intervention prioritaires pouvant aider les collectivités locales à élaborer et à mettre en œuvre des politiques urbaines pour le développement durable d'une ville. Avec l'aide de l'analyse multicritère on peut construire des scénarios qui peuvent être en aide pour traiter les projets de réhabilitation urbaine de manière territorialisée, en s'appuyant sur une

démarche de prospective territoriale, utile aux politiques publiques de gestion du territoire et des espaces urbains et péri-urbaines.

La démarche, comme nous l'avons décrite, se différencie par sa façon dynamique dans toutes ses composantes. Elle a été conçue de cette manière pour la rendre efficace et pour l'améliorer en tout temps. La valeur, de nature hybride, est attachée à des enjeux qui peuvent varier dans le temps et dans l'espace. En effet, déjà dans la phase de construction de la liste des indicateurs et dans la phase d'utilisation des résultats elle peut être ajustée et intégrée par d'autres variables selon les connaissances survenues dans le temps. Cette particularité est aussi dans l'utilisation des études de cas effectués et aussi dans le processus d'évaluation du projet avec l'évaluation ex ante et ex post intégrée dans le cycle de vie du projet où les acteurs jouent un rôle important.

L'application de notre méthode se différencie pour être rigoureuse dans son processus d'évaluation du projet. En référence à la problématique sur le choix des indicateurs à la section 1.6 notre démarche a rempli les lacunes mises en évidence. À cet égard, la méthode proposée prend en considération un ensemble de données spécifiques, tel que décrit au CHAPITRE 5 à la section « 5.5.2 Integration of Indicators into Dimensions », dans le processus de gouvernance où les citoyens participent activement au processus d'élaboration d'une liste d'indicateurs pour la prise de décision, afin de mieux contextualiser le projet et qui reflètent les attentes de la communauté locale. La méthode mise en place tient compte des défauts et des limites des outils existants et prend en considération des indicateurs locaux pour évaluer la durabilité en termes de toutes les dimensions, c'est-à-dire la dimension socio-économique, la dimension environnementale et la dimension institutionnelle et culturelle pour établir une planification efficace et stratégique du contexte. Dans un cas réel, cela est applicable dans l'étape ex ante du cycle de vie du projet. C'est à cette étape que les acteurs municipaux et les représentants politiques et les consultants entre en jeux avec la communauté locale pour choisir les indicateurs potentiels à utiliser. Cela a été bien explicité par Moussioupulos (2010) qui affirme que les indicateurs doivent parvenir par une collaboration active de la communauté locale à évaluer le projet en considérant toutes les

dimensions et ils doivent avoir des caractéristiques spécifiques en fournissant des informations environnementales, sociales et économiques locales pour attendre les objectifs de durabilité.

De plus, la proposition d'intégrer dans le cycle de vie du projet urbain de nouvelles phases (évaluation ex ante, design et évaluation ex post) et d'impliquer ces acteurs (citoyens et usagers) dans la prise de décision amène ces groupes d'acteurs à l'engagement à long terme dans leur territoire. La réussite de bien fonctionner de cette méthode est d'impliquer tous les groupes d'acteurs concernés que simplement des acteurs politiques, professionnels et techniques comme dans les projets classiques.

Dans la littérature on a constaté qu'il n'y a pas un processus bien défini où les groupes d'acteurs interviennent d'une façon ponctuelle pour favoriser une évaluation maximale du projet. Cela nous l'avons bien mis en évidence dans la présentation de notre méthode dans le CHAPITRE 5, où chaque outil ou approche méthodologique prennent en considération différents groupes d'acteurs sans un ordre préétabli. C'est pour cela que la méthode proposée vise à faire dialoguer les acteurs impliqués dans le cycle du projet pour maximiser l'expertise de chacun. Aussi, elle vise à opérer un rapprochement entre les questions d'évaluation et de représentation spatiale comme nous l'avons fait dans les études de cas faits. En plus elle peut être améliorée en tout temps, sa valeur, de nature hybride, est attachée à des enjeux qui peuvent varier dans le temps et dans l'espace et peut être ajustée et intégrée par d'autres variables.

Dans un contexte réel, cela est applicable dans l'étape du design du cycle de vie du projet où les groupes d'acteurs impliqués (les institutions et les associations, les promoteurs du projet, les experts, les consultants et les usagers) sont mis à dialoguer avant l'approbation du projet. Dans cette phase, il y a la possibilité de constater si le développement du projet est bien orienté vers les objectifs de durabilité établis dans la phase ex ante et apporter, si cela est le cas, des modifications avant la phase d'approbation du projet.

Les enjeux en matière de gestion et d'application de cette méthode d'évaluation rendront le système plus efficace, convivial (surtout en ce qui a trait à l'évaluation du territoire stratégique), facile à appliquer, efficient, transparent et fiable. Il s'agit avant tout d'une méthode plus pratique permettant d'appliquer le processus d'évaluation aux politiques et aux stratégies et d'intégrer, d'une manière plus efficace et ponctuelle, les aspects environnementaux, sociaux et économiques concernant le transport, l'énergie, l'économie et le développement d'infrastructures.

L'application de la méthode proposée rend plus simple et pratique l'évaluation de scénarios soit d'un point de vue conceptuel, mais surtout d'un point de vue de stratégie de développement territorial en mettant les citoyens de façon efficace dans le processus d'évaluation. En effet, notre méthode, en considérant la participation des citoyens essentielle, introduit leur participation dans les phases clés du cycle de vie du projet (ex ante, design, approbation, implémentation et utilisation) afin d'améliorer le processus d'évaluation et pour une acceptation sociale partagée avec tous les acteurs. C'est dans la phase de programmation, dans un contexte réel, que les acteurs impliqués doivent prendre en considération les outils pour la prise de décision (analyse multicritère et SIG) pour l'élaboration des scénarios afin de contextualiser le projet au territoire et répondre aux attentes de la communauté locale.

Les résultats des études de cas ont jeté un éclairage nouveau sur l'ampleur et l'actualité au niveau international de la préoccupation de l'intégration des acteurs dans la prise de décision et aussi de constater les efforts de sortir des approches purement environnementales pour parvenir à un équilibre avec les autres dimensions de la durabilité (sociale, culturelle, institutionnelle et économique). A l'heure actuelle, il semble que n'existe pas une méthode ou un outil qui serait applicable dans n'importe quel contexte, qui englobe toutes les problématiques dans le processus de développement d'un projet urbain (Sharifi and Murayama, 2013).

Un autre constat des résultats est l'utilisation de l'échelle d'intervention. Peu d'outils sont propres à l'échelle du quartier. Ils sont majoritairement initiés pour s'adresser aux autres

échelles d'interventions et souvent ils se situent à l'échelle du bâtiment ou de la ville. Cette problématique on l'a mise en évidence dans l'étude de cas présenté au CHAPITRE 3. L'appréhension et l'application d'intégrer les dimensions de la durabilité à cette échelle manque largement (Sharifi and Murayama, 2013). La méthode d'évaluation développée met en évidence une évolution pour intégrer les objectifs de la durabilité à l'échelle du quartier. La mise en œuvre des grilles d'indicateurs et des acteurs et leur intégration dans les champs thématiques de la durabilité ont aidé à trouver les actions à prendre dans un projet de réhabilitation urbain qui se veut être durable.

La méthode proposée intègre les problématiques de la prise de décision dans le processus du projet pour d'aider à l'appréhension des enjeux du projet urbain dans son cycle de vie, dans le rôle des différents types d'acteurs en passant par une évaluation ex ante pour la programmation et la prise de décision.

Cependant, il est intéressant de remarquer que la réussite d'une telle méthode ne dépend pas seulement de la connaissance et les travaux des maîtres d'œuvre mais est aussi confiée à tous les autres acteurs du projet. Cela est nettement prouvé dans les résultats de croisement des acteurs dans le cycle de vie du projet et dans l'intégration d'eux dans les champs thématiques de la durabilité. Car les critères d'élaboration du projet ne parviennent pas à répondre, par eux seuls, aux enjeux de la durabilité et de ses thématiques à aborder. La structure de la méthode proposée (le tableau de présentation synthétique et la liste des critères d'élaboration du projet) se caractérise par son approche multicritère et transversale de la démarche vers les enjeux de la durabilité.

CHAPITRE 7

CONCLUSION

L'étude proposée dans cette thèse nous a donné la possibilité de répondre à plusieurs questions et aussi de proposer une approche innovante dans le domaine de la planification stratégique. L'objectif de ce travail était d'étudier systématiquement l'intégration d'indicateurs socio-économiques locaux dans une approche en matière d'évaluation d'un quartier durable. Cet objectif a été atteint en développant une démarche qui visait à répondre à notre question de recherche : quels seraient les indicateurs socio-économiques et territoriaux reflétant les attentes des habitants et comment les intégrer dans un outil d'évaluation pour la conception d'un quartier durable? Cette question a été posée à la fois d'un point de vue théorique et pratique en appliquant notre proposition dans deux études de cas.

D'un point de vue théorique on a pris en considération les indicateurs souvent utilisés par les municipalités et dans des études précédentes en particulier, mais nous sommes arrivés à la conclusion du besoin de développer de nouveaux indicateurs qui pouvaient être utilisés dans une démarche méthodologique innovante en tenant compte des indicateurs qui permettent de mieux évaluer et contextualiser des projets de réhabilitation urbaine à la ville. La structure de la démarche méthodologique développée peut apparaitre un peu complexe pour ce qui concerne la sélection des indicateurs car, pour prioriser les indicateurs nous avons utilisé l'analyse multicritère et l'analyse statistique. Mais, cela ne peut pas être un motif d'impasse, car les résultats obtenus sont satisfaisants. En effet, à l'heure actuelle, cette situation ne peut pas être un obstacle pour les municipalités, car plusieurs logiciels se trouvent et ils rendent cette phase de priorisation abordable. En plus ces logiciels donnent aussi la possibilité d'évaluer plusieurs scénarios en appliquant une différente pondération aux indicateurs sélectionnés.

D'un point de vue pratique, on peut affirmer que l'application d'une méthodologie innovante ne suscite pas encore l'attention que le système actuel aurait besoin afin de rendre la gestion des politiques urbaines conforme aux intérêts locaux. En effet, les acteurs impliqués ne semblent pas disponibles à opérer un changement soudain dans le choix des politiques urbaines, parce que ces choix sont parfois complexes et liés à des intérêts économiques et ne peut pas le mettre en œuvre à court terme.

On peut dire que la démarche méthodologique développée est une véritable solution dans le domaine de la prise de décision pour les municipalités qui veulent mettre en place une planification stratégique capable de répondre exhaustivement aux exigences de ses habitants. La démarche proposée prend en considération le contexte d'intervention avec la complexité de ses composants, car ils apparaissent à la fois complexes et difficiles à résoudre, cependant, la démarche s'adapte à chaque contexte territorial. La démarche proposée cible les friches industrielles, mais elle peut être appliquée dans d'autres contextes. Le cas échéant, son application dans d'autres domaines et contextes devra faire l'objet de tests supplémentaires.

Les principales contributions de cette recherche concernent le développement d'une démarche méthodologique et la mise en œuvre d'un étalonnage des aspects socio-économiques locaux qui sert de cadre pour l'évaluation des projets de réhabilitation des friches industrielles et peut ensuite servir à gérer la prise de décision et à améliorer les approches existantes. Cette démarche s'appuie sur ses fondements théoriques, sur une meilleure sélection de certaines variables et une contextualisation des projets pour optimiser la collaboration des parties prenantes afin de joindre les attentes de la communauté locale.

Les contributions secondaires résident dans l'élaboration d'une théorie sur la collaboration des participants au projet à ses différentes étapes, ainsi que dans l'évaluation en profondeur de leur impact sur la prise de décision et le développement de projets plus durables. Une autre contribution de cette recherche est l'application d'une approche systémique et la combinaison et l'utilisation de techniques utilisées (analyse statistique et multicritères) pour

l'analyse qualitative des données, qui sont de plus en plus populaires, mais qui restent rares dans la pratique.

Les résultats de nos études de cas mettent en évidence quatre recommandations principales dans les projet de réhabilitations urbains: 1) mettre en œuvre des stratégies d'habitations abordables et des fonctions des services, en particulier dans les arrondissements étudiés; 2) renforcer la valeur sociale et la réhabilitation des espaces inutilisés, en particulier dans les zones à haute densité en préservant les terres agricoles en proximité de la ville; 3) améliorer l'accès aux transports en commun dans les zones périurbaines et 4) utiliser des indicateurs et les attentes locales pour stimuler l'activité économique.

L'originalité des travaux réside dans la sélection des indicateurs locaux et de leur intégration dans un outil reconnu et dans de la collaboration des parties prenantes et de leur contribution dans chaque étape du projet (cycle de vie du projet). Cette rationalisation de placement des acteurs dans les étapes du projet améliore la réalisation de projets de quartiers durables. D'un point de vue théorique, ce travail vise à combler une lacune dans la littérature selon laquelle le concept de la prise de décision semble, à l'heure actuelle, mal défini.

Bien que nous nous sommes appuyés sur d'autres formes de méthodologie reconnues, la démarche proposée, même si elle a eu des résultats satisfaisants, a besoin de se renforcer sur la participation des parties prenantes, car en incluant des formes de participation active (rencontre avec les décideurs de la ville, avec les comités du quartier, interviews avec les citoyens), elle peut contribuer à la réalisation de quartiers équitables.

Les résultats de recherche démontrent que les outils d'évaluation de la durabilité urbaine fournissent un ensemble de critères solides pour l'évaluation de la performance durable d'une zone urbaine, bien que la méthode d'évaluation doive être adaptée en cas d'extension de la zone d'étude, quartier par rapport à la ville, pour surmonter les défis liés au manque de résolution et de qualité des données et prendre en compte les niveaux d'incertitude associés aux résultats de l'évaluation.

La principale possibilité pour les travaux futurs consiste à l'optimisation de la phase de participation des parties prenantes dans la gestion de la prise de décision dans un projet réel afin que les avantages de l'approche méthodologique proposée puissent être évalués.

Bien que l'élaboration de l'outil se soit basée sur deux études de cas en intégrant les caractéristiques spécifiques du projet de réhabilitation ainsi que les conditions territoriales locales dans lesquels ils ont été réalisés il apparait pertinent que la démarche proposée accompagne un projet réel dès sa conception puis tout au long des phases de construction et d'opération. Une étude efficace pourrait être faite en partant du cycle de vie du projet et par l'application d'un outil d'évaluation pendant tout le cycle de vie il pourra s'avérer un incontournable défi pour l'avancement de la recherche sur l'organisation de nos villes. Une étude expérimentale mettant en place toutes les phases de l'approche méthodologique permettrait de tester l'efficacité de l'approche dans un contexte réel. Ainsi, il serait indispensable pour assurer le succès de tels projets de disposer d'une connaissance accrue de la situation initiale et avoir pleine conscience des lieux afin de permettre une véritable collaboration entre le secteur public, le secteur privé et la population.

Le présent travail constitue une première étape pour le développement d'un outil d'aide à la décision dans le contexte d'une planification urbaine durable en identifiant les données, les tâches et les flux de travail nécessaires à une telle analyse. Les recherches futures devront inclure le croisement des certaines bases de données. Aussi, comme nous l'avons fait, la combinaison du SIG avec d'autres approches d'aide à la décision (analyse multicritères AHP ou d'autres) et la comparaison des résultats, l'automatisation des données géo-référencées peut rendre l'outil d'évaluation efficace, flexible et adaptable à d'autres contextes spécifique de la ville.

Le projet durable doit se comprendre comme un processus dynamique, qui sous-tend l'implication de nombreux acteurs et un apprentissage commun de la manière dont la durabilité peut être transposée (Mathieu, 2017). En partant de notre proposition et des objectifs de durabilité et de gouvernance, la collectivité, à notre avis, pour jouer un rôle

décisif dans tout le processus du développement des quartiers durables doit être supporté par des outils d'aide à la prise de décision.

ANNEXE I

Integrating an Environmental and Socio-Economic Assessment Tool for the Development of Brownfield Development Projects

Francesco Cappai[a], Daniel Forgues[b], Mathias Glaus[c]

[a, b] GRIDD-ÉTS – Département de génie de la Construction, École de Technologie Supérieure, 1100 Notre Dame W, Montréal (QC), Canada H3C 1K3
[c] STEPPE-ÉTS – Département de génie de la Construction, École de Technologie Supérieure, 1100 Notre Dame W, Montréal (QC), Canada H3C 1K3

Cette annexe a été présentée à la conférence Sustainable Built Environment (SBE) Regional Conference, dans la section : Expanding Boundaries : Systems Thinking for the Built Environment tenue à Zurich, en Suisse, du 15 au 17 Juin 2017.

Article publié dans « G. Habert, A. Schlueter (eds.): Expanding Boundaries © 2016 vdf Hochschulverlag AG an der ETH Zürich »

Abstract

In the urban development process, stakeholders (local politicians, businessmen, academics, neighborhood groups, etc.) involved in urban policies are required to make strategic decisions for their territory in a strategic manner. The available tools are poorly adapted for this process. The evaluation tools most commonly used (LEED, CASBEE, BREEAM and SBTool, etc.) have a complex structure and do not provide the results required in the case of brownfield projects. They do not include the involvement of all stakeholders in the early phases of the project. Moreover, their indicators are not equally distributed among the three dimensions of sustainable development (environmental, social and economic) to reflect the context and local expectations.

This paper presents a transversal and interdisciplinary study on sustainability that examines local indicators that can be used in brownfield projects. The study proposes the construction of an assessment tool derived from an analysis of the methods used in urban development projects.

The study considers a selection of 20 items related to restructuring case studies of North American and European brownfields. A multidisciplinary approach is used to consider the players involved in all phases of the project. The goal is to identify and classify the elements that are needed for decision making, including the indicators related to environmental and socio-economic components, in order to develop an effective evaluation tool.

Keywords: Sustainable building; brownfield; sustainability assessment; sustainability coverage; subjectivity; adaptability; applicability

Introduction

Urban population has grown rapidly over the last century (US Census Bureau, (World population) 2015 [1]). Also, the demand for land has increased rapidly and the total value of land and real estate has increased steadily over the last 40 years [Isaac, 2002 cited by 2]. Climate change, loss of biodiversity and environmental pollution make it imperative to intervene in the planning of cities and their components (UNEP, 2014 [3]). In the development process of cities, stakeholders involved in urban policies have been called upon to make strategic decisions for their territory [4]. The redevelopment of brownfield sites is now considered a sustainable land use strategy [5]. Until recently, these sites had been neglected by developers in favor of "Greenfields" because of the high costs of soil remediation and the upgrading of existing infrastructure [6]. Our research aims to develop an intervention framework for analysis and decision making.

This paper presents the first part of research that aims to identify the literature for the framework of intervention. Here are the three stages: (i) Identification of the stakeholders involved in a brownfield redevelopment process and their involvement in the project's phases; (ii) identification of the dimensions covered in each study and the association of thematic fields; and (iii) identification and classification of indicators for each dimension. This classification is the basis for developing an effective evaluation tool for the redevelopment of brownfield sites.

The Challenges of Upgrading Brownfields

The restoration and redevelopment of brownfield sites can provide economic, social and environmental benefits, including environmental quality restoration, improvement of the quality of life for citizens, improving health, providing land for commercial housing and the creation of employment within the urban environment [7-9]. The link between scientific and local knowledge can contribute to a better understanding of the implications of sustainable development [9, 10]. The assessment tools have become sectoral approaches that consider one dimension over another. The best-known assessment tools, LEED-ND® (North America), BREEAM Communities (UK), SBTool, GreenStar (Australia), and CASBEE-UD (Japan) [11], are voluntary approaches to assess projects according to the project's scale, using their own indicators to achieve certification. Despite their lack of consideration of social and economic aspects [11], these sets of standards contribute to a sound knowledge base but only yield partial results. A true evaluation tool must incorporate all of the sustainable development issues. It must be able to clearly identify the project objectives and classify and prioritize them based on local interests. A new methodological framework (a summary presentation in the form of a table and the list of a project's development criteria) must be built. This methodological framework should be characterized by a multi-criteria, transversal and comprehensive approach to move towards sustainable development. The assessment tools would need to be guided by the normative vision of sustainability, and at the

same time be directed towards a framework for the implementation of the users' various requirements [8]. A key factor for success at a local level is the ability to contextualize a project for its city. This contextualization can be achieved through the participation of local stakeholders who can help in the design of policies, plans or projects that best meet the needs of local communities [11]. Experience with participation in strategic planning design and specific local governance by process could reduce the uncertainty associated with future redevelopment and investment promotion [McCarthy, 2002, Nijkamp et al., 2002 cited by 9]. Sustainable development, design issues and project development must be interlinked to create a real process [4].

Research Methodology

The first part of the research consists of a report on methodological approaches and frameworks; international tools that are completed or under development. The identification of these fundamental elements will identify their roles and their organization in the redevelopment project structure. Our analysis is based on the identification of criteria, targets and indicators. The objectives are to propose a set of criteria that characterize urban redevelopment projects and to carry out the identification of dimensions and stakeholders in order to best select and classify the indicators associated with each dimension.

The Dimensions of Identification

Of the 20 selected articles, 13 are based on the three classical dimensions of sustainable development, environmental, social and economic. Only 7 articles stress the importance of adding and evaluating appropriate indicators of socio-cultural dimensions. Addressing only one or two themes is not enough to implement a process for achieving sustainable urban development. As several authors have indicated [8, 9, 12] the objectives of sustainability must be addressed in order to achieve an approach that deals with registering a redevelopment project in the urban fabric in a sustainable way. We chose a combination of thematic and aggregation through an analysis of case studies. This study consists of three phases: 1) A comprehensive inventory of the thematic areas covered in the literature. in order to select the subject areas that encompass all the dimensions of sustainability to be integrated into a neighborhood project. This inventory of thematic areas consists mainly of existing tools, research, and field work: LEED-ND 2009, BREEAM Communities, CASBEE-UD, SBTool, and Green Star [11]; 2) A selection and aggregation of the thematic areas that are most often discussed in these studies; and 3) A selection of criteria which include sustainability aspects. The choice guided by these criteria can thus classify the thematic fields into three dimensions: environmental, socio-cultural, and economic. These three dimensions are then translated into eight thematic fields, summarized in Table A I-1.

Table-A I 7-1 - Dimensions and individual thematic fields in articles

Dimension	Thematic field
Environmental valuation	Natural Resource Management (Storm water, sewage, alternative energy, etc.), biodiversity, quality of natural areas
	Environmental protection (floodplains, rivers, lakes, parks, wetlands, animals, etc.)
	Improved comfort and health (site pollution)
Equitable social value and social responsibility	Strengthening cohesion and social equity
	Enhancement of the architectural (buildings and materials) and historical heritage (preservation of historical memory)
Economic strategy	Cost reduction
	Increase of cohesion (accessibility and transportation) and economic dynamics (employment and business)
	Multi-functionality of the territory, territorial competitiveness

Identification of Stakeholders

Following the literature review (20 relevant articles on brownfield redevelopment) seven stakeholder groups have been identified. The analysis in the articles led us to reflect on the need for a renewal of the identification of the stakeholders involved in a brownfield redevelopment project. Their involvement was classified based on the respective project phases (Table 2). The goal was to identify the level at which each group of stakeholders is involved in decision making. It is in this context that the roles of these stakeholders become more complex and varied. Without going exhaustively into the modality of participation, we can distinguish groups of key stakeholders in a sustainable project process. As shown in Table 2, these actors have been classified into seven groups according to their level of intervention and also in terms of their participation in the project hierarchy according to their discipline. The participation of stakeholder groups in the project phases is essential, but each stakeholder group must contribute specifically at certain phases of a project to achieve a successful sustainable urban redevelopment. We identified two levels of participation: essential and conditional. The first five stakeholder groups are classified as essential, while the last two groups are considered to have conditional participation in the design phase and project assessment. This latter classification is given to citizens who had not yet been included in the project phases. [7, 10, 11, 12]. This approach puts people at the center of decision making and permits them to play a decisive role in the evolution of new solutions and to promote sustainability [10, 11].

Table-A I 7-2 - Involvement of stakeholder groups in a project's phases

Group of actors	Public or Private	programmin	design	implementin	use
National policy makers	National Policy, Ministerial, administration	x			
Local policy makers	City and community	x	x		x
Institutions and associations	Urban services, service companies, associations, local housing authority, non-governmental partner, academics, building managers	x	x	x	x
Master of private work	Investors, developers, private landlords	x	x		
Master of implementable and experts	Consultants designers, urban planners, sociologists engineers, consultants,experts,renovation agencies	x	x		
Operational actors	Companies, private contractors, technicians, craftsmen		x	x	
Users	Citizens (owner, tenant),neighbors, employees		x	x	x

This group of players can be a driving force that not only motivates new policy decisions and the actions of professionals, but who also intervenes directly in a project [10, 14-19].

Selection and classification of indicators associated with their dimensions

Table 3 provides a detailed description of the indicators used in each case study and the objectives identified for each project. By analyzing Table 3, it can be observed that the number of indicators considered is different for each author.

Table-A I 7-3 - Indicators and targets used in the literature

Authors	**Number indicators**		
	Env.	**Soc.**	**Eco.**
(Greenberg & Lewis, 2000)	1	8	5
(Thomas, 2002)	13	8	9
(De Sousa, 2003)	17	21	13
(Wedding & Crawford-Brown, 2007)	10	20	10
(Chen et al., 2009)	1	1	9
(Doick et al., 2009)	9	16	8
(Brill, 2009)	2	6	3
(Pediaditi et al., 2010)	5	5	5
(Schädler et al., 2011)	14	18	8
(Rall & Haase, 2011)	4	4	2
(Yu et al., 2012)	0	0	2
(Chrysochoou et al., 2011)	9	5	8
(Cappuyns & Kessen, 2012)	7	6	1
(Sardinha et al., 2013)	5	4	3
(Bartke & Schwarze, 2015)	8	11	7
(Beekmans et al., 2015)	4	4	9

All the models concur that all three dimensions should be covered and that the social and environmental aspects should have greater amplitude, especially when planning developments affecting brownfield problems. The tools assessed here are not able to

adequately assess all three dimensions. Some indicators are related to urban forms yet are not treated with the appropriate tools. Another observation is that the number of indicators becomes less representative in some studies and that project objectives sometimes take the place of indicators. This project evaluation allows us to see the shortcomings of the tools used by professionals and municipalities, deduced from the intersection of the themes and indicators of the tools used in the case studies.

Proposed Methodological Approach

As shown in Fig. 1, the proposed methodological approach consists of three main steps. All the stakeholders involved in the redevelopment process are identified in the first stage.

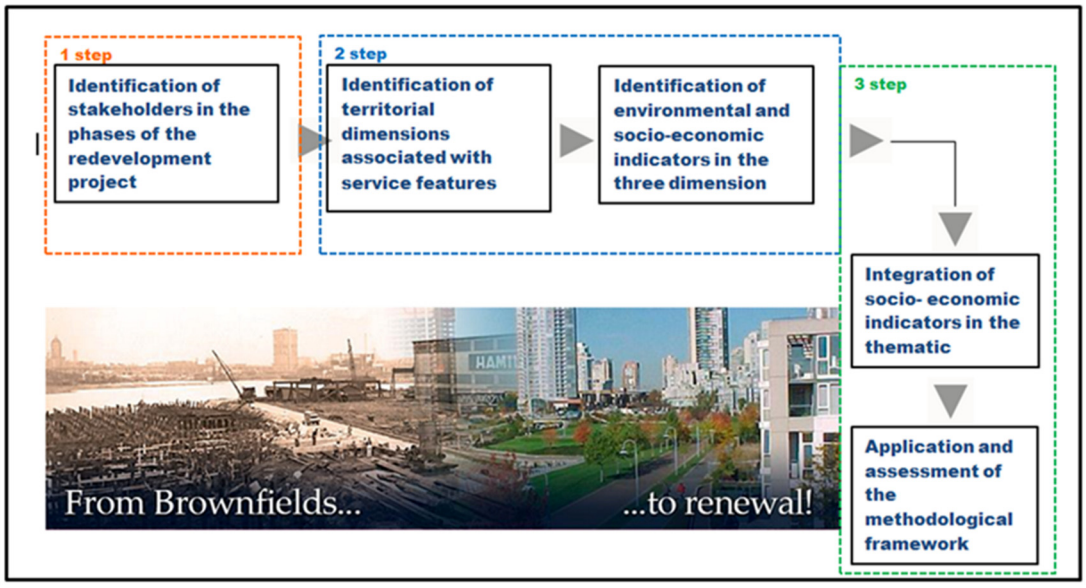

Figure-A I 7-1 - Methodological approach for the evaluation of a project

An inclusive vision of stakeholders is incorporated, considering a player as any stakeholder group or individual that is directly or indirectly influenced by the redevelopment process [Freeman, 1984; Mitchel et al., 1997 cited by 9]. In the second phase, the clusters of stakeholders are assembled in a common pattern by a transverse approach. We recognize the interrelationship between the themes in a field, and the various fields that connect the common themes. For example, steps to reduce the consumption of resources lead to reducing project costs, which is also a result of the promotion of sustainable lifestyles in terms of social consumption. This grouping makes it possible to take into account the linkages and interdependencies between dimensions and themes. In the third step we classify all the themes that we believe are necessary for the redevelopment of a brownfield site. The purpose of this approach is to establish the level of complexity of the brownfield problem and also to form a structure of criteria with which to establish the actions to be taken to achieve the redevelopment. To proceed with the integration of aspects of sustainable urban development,

the working method is to cross the dimensions with the project's parameters to translate the objectives for a project's development.

Table-A I 7-4 - Redevelopment settings

	Thematic field	**Redevelopment settings**
Environmental valuation	Natural Resource Management (Stormwater, sewage, alternative energy, etc.), biodiversity, quality of natural areas	Infrastructure system water; Water consumption (including water quality);Energy consumption; Green spaces; Water surface; Vegetation
	Environmental protection (floodplains, rivers, lakes, wetlands, parks, animals, etc.)	Use of space; Living areas; Landscape (unnatural barrier, bridges, viaducts); Enhancing biodiversity; Morphology; River system
	Improved comfort and health (pollution of the site)	Ventilation; Physical comfort; Proportion of own sites; Soil quality; Lighting
Equitable social value/social responsibility	Strengthening cohesion and social equity	Accessibility; Public spaces; Density; Distribution services; Inclusion; Security
	Enhancement of the architectural (buildings and materials) and historical (preservation of historical memory) heritage	Structure; Materials; Technology; Protection; Care and maintenance; Form; Architectural fragmentation; Architectural quality
Economic strategy	Cost reduction	Waste management; Distribution functions; Service – Business; Contiguity;
	Increase of cohesion (accessibility and transportation) and economic dynamics (employment and business)	Streets network; Public transport; Fluidity of movement; Parking; Links, connections; Economic diversification
	Multi-functionality of the territory, territorial competitiveness	Location; Connections; Partition areas; Urban form (urban fabric); Public areas; Historical activities

From these crossings eight thematic fields will be selected in order to identify the issues to consider for successful integration. Table-A I 7-5 shows the linking of eight thematic fields with the parameters of the redevelopment project. It is assumed that between the themes and phases of project design, there are links to arrive at intelligent redevelopment objectives. For example, architectural heritage enhancement is related to urban form and to the historic preservation of buildings. There is also a link to the multi-functionality of services, the use of the territory and the social relations of citizens and economic activity at the industrial site.

The objective is therefore to contribute to brownfield redevelopment by transforming the traditional project criteria to support a sustainable redevelopment approach in which stakeholders use these criteria as the basis of communication with other stakeholders.

The list of criteria is based on two groups of data: All the themes proposed for sustainable redevelopment early in our analysis were expressed as a set of criteria for the design of a sustainable industrial redevelopment (see Table-A I 6 4). This was done to meet the goals (thematic). In practice, by crossing each theme with each parameter we were able to establish the integration criteria. This was done with the intention to collect and consolidate criteria that meet different objectives with the parameters of design and also assemble the same practical criteria.

Discussions

Thus far, the study has only revealed partial results, as there is not much specific literature that considers the tangible socio-economic aspects in brownfield development. Most studies that consider environmental issues prioritize soil contamination and decontamination. New criteria are essential for sustainable development solutions, and in this case, for the reuse of industrial sites. The tools used by professionals and municipalities have their shortcomings in terms of project evaluation. A tool must be able to clearly identify a project's objectives and to classify and prioritize them based on local interests. The need for regeneration of the natural environment, including the landscape and biodiversity, must be a priority [12]. The quality of brownfield conversion needs to consider users' expectations for the rehabilitation of these sites. We believe that the value of these sites and their re-appropriation for productive use must be taken into consideration. This can be attained through the use of suitable indicators. As stated by [Willians et Dair (2007) and Ballesteros et Ramirez (2007) cited from 9] attachment to cultural heritage must be among the objectives of redevelopment projects because of the influence of the concepts of landscape and the social aspects of the community. The indicators related to the conditions of public safety, accessibility, etc. also need to be part of the redevelopment of brownfields [6, 8, 9, 12]. A new methodological framework characterized by a multi-criteria, transversal and comprehensive approach is a requirement for moving towards sustainable redevelopment.

Conclusions and Future Work

The sustainable development approach has led to a renewal of the conceptual issues of project development. The new criteria resulting from the crossing of thematic issues with the parameters of project design allow for better control of a project's implementation. These improvements are especially notable in the early stages of programming and project design. However, it is interesting to note that the success of such an approach in the context of a development project depends on the contributions of all of a project's stakeholders, and not only on national and local policy makers. This is clearly demonstrated in the results of our crossing the thematic issues with project parameters: project development criteria fail to address several issues that are required for a successful urban redevelopment. We prefer to leave the methodology open to supplementary and continuous evolutions. Without a proper system of checks and balances, the methodology will never improve. Checks and balances are necessary to validate the developed tools.

Acknowledgments

We thank all the stakeholders that contributed with their knowledge, time and ideas to this study. We would also like to acknowledge Claudiane Ouellet-Plamondon and Conrad Boton for their incisive comments on the text.

Finally, we are grateful to the two anonymous referees for their thoughtful observations.

ANNEXE II

Reducing the Impacts of The Built Environment on the Environment Through the Integration of Socio-Economic Indicators in Certification Standards

Francesco Cappai[a], Daniel Forgues[b], Mathias Glaus[c]

a, b GRIDD-ÉTS – Département de génie de la Construction, École de Technologie Supérieure, 1100 Notre Dame W, Montréal (QC), Canada H3C 1K3

[c] STEPPE-ÉTS – Département de génie de la Construction, École de Technologie Supérieure, 1100 Notre Dame W, Montréal (QC), Canada H3C 1K3

Article présentée à la conférence « World Sustainable Built Environment Conference 2017 – Transforming Our Built Environment through Innovation and Integration: Putting Ideas into Action » - Tenue à Hong Kong, en Chine, Juin 2017.

Abstract

Some cities are recognized for their successful application of forms of revitalization of their habitat, while other cities are clogged and choked with traffic and pollution. The inclusion of "sustainable development" in the field of construction is behind new methodologies for achieving a more sustainably built environment. The use of tools to measure the degree of sustainability of cities is the method that receives the most attention in developed countries. However, none of the tools used to date covers all three pillars of sustainability (environmental, social and economic). Previous studies show that the participation of citizens and experts is not taken into consideration. This study (paper) will aim to explain the process of our research for integrating socio-economic aspects in the CASBEE-UD standard (neighborhood level). First, the study will seek to analyses the existing built environment through a geographic system (GIS) for the identification of spatial indicators. In addition, from the use of social and economic data through the use of statistical analysis, we will select the data that present a true picture of our territory (either an existing district or a new district). The criteria selected in these analyses will be used in a (in an advanced analytic tool) multi-criteria tool to establish the most efficient indicators in order to integrate them into the CASBEE-UD standard.

Keywords: neighborhood sustainability assessment, sustainability coverage, applicability

Introduction

In recent decades, much has been written about the concept of the need for sustainability in cities. The reason for this is that during the last century, the world has witnessed many social,

economic and urban. Everyone knows that the construction sector has a huge impact on the consumption of resources. According to data disclosed by the leading research institutes (World Commission on Environment and Development (WCED), European Commission, 2009), construction industry uses globally about 40% of energy and 40% of natural resources (raw materials and other materials) and produces 25% of waste. Several communities and institutions have developed new methodologies for monitoring the sustainability status of their cities. Some communities (United States, European Community, United Kingdom, Japan, etc.) have launched tools to ensure that the hardware requirements of their cities strive towards sustainability. Three sets of certification have been developed recently: LEED-ND (1998) developed by the Green Building Council in the US, BREEAM Communities (1992) developed by the British organization BRE Global, and CASBEE-UD (2004) developed by IBEC Institute for strengthening the environment and energy conservation in Japan. All these standards are developed at the neighborhood level. Certification standards mentioned above are the most known and used, but several weaknesses especially the socio-economic aspects. To measure progress towards this desirable state of sustainability, measurable indicators are required to assess urban efforts in the economic, social, environmental [1]. Therefore, the importance of the issue of sustainability in general and in particular on sustainable urban planning in communities, has emerged as one of the key issues that must be taken into account by the authorities and experts. In the same context, at present, there are many areas that have experienced a marked change in their own style and their quality of use. To achieve these objectives it is necessary to develop clear objectives and effective sustainability criteria. Also, it is necessary to understand and analyses existing certifications, specifically the criteria, which structure and guide the entire evaluation process. The goal is that the knowledge of the certification standards should help in the future development, for a more complete and efficient certification in order to have a tool based on strong sustainability criteria "triple bottom line". The aim of this study is to develop additional indicators to those existing in the certifications of tools to assist planners and citizens to improve the assessment of the built environment (neighborhoods). Our research is guided by the development of an appropriate methodological approach based on the integration of socio-economic aspects to the CASBEE-UD standard. The article is structured in the following manner: chapter 1- context; the second chapter is dedicated to the review of the literature; and, the third chapter describes the methodology of our approach; the fourth chapter describes the application of our methodology framework for CASBEE-UD standard; the results and discussion will finish this study.

Context

In the second half of the twentieth century, the world's urban population has quadrupled from 732 million in 1950 to 2.8 billion in 2000 to over 3.2 billion in 2006 (Redman, 2010; United Nations, 2006) (cited by [2]). The year 2007 marked a turning point in history when half the world's human population lived in cities (Cities Alliance, 2007). This growth has caused a lot of pressure on a lot of resources and contributed to the depletion of natural and environmental resources [2]. Urban society recognizes that activities that are developed for the production and processing of urban space influence and determine the survival of natural systems. There is now a consensus on the importance and the need for strategies to mitigate

these problems and gradually increase the benefits of cities [3]. In addition, the need for corrective actions reinforces the idea of developing new models to replace the current models, to reorient activities and human technology towards sustainability, and to ensure the survival of contemporary urban society [1, 2]. In recent years there have been various collaborations in the field of construction to environmental objectives and sustainable development [4]. Certification standards are an example of the principle tools that encourage market competitiveness "green." In addition, standards are working to improve the quality of products and services while introducing new criteria and values of productive activities [4, 5]. In the field of construction, the certifications are used in several countries (e.g. USA, European Community, Japan) [6] [15] [4]. They are used mainly to guide architects to techniques for the construction of buildings based on rigorous energy efficiency. The standards in the field of urban planning are a recent phenomenon [14,16]. They have recently developed initiatives which aim to introduce sustainability criteria in the planning process (e.g. the construction of new neighborhoods or rehabilitation of urban areas). In addition to these tools, which are used for products and value-added services, communities use them as an instrument of local politics. They are also used as means of verification of compliance with regulatory guidelines, or for granting financial credits and investment or to the development of private projects [1, 2].

Justification of Context

The scale of the neighborhood is the area where we find all the dimensions to determine the design of a more sustainably built environment. This scale between the scale of the city and the building is very interesting in this context, in operational terms, as it is well suited to the testing of specific practices to increasing urban sustainability [17]. It makes it possible to grasp tangibly urban issues that clearly exceed the size of a single building. The need for coordinated control of urbanization and mobility, the creation of joint dense clusters and the search for a better quality of urban life can be addressed through concrete solutions [1, 6] [17]. It is in this perspective that emerges the concept of "sustainable neighborhood", namely the realization of urban centers, dense and mixed, whose overall quality meets a thorough vision of sustainability. A number of parameters are however needed to apply the concept of sustainable neighborhood [17].

The Normative Evolution

In the context of urban planning, there is now a broad consensus that sustainability has four main dimensions: environmental, social, economic and institutional. All these dimensions should be taken into account for sustainable development (Valentin and Spangenberg, 2000; Conte and Monno 2012 cited by [5]). The evaluation of sustainability is considered the latest generation of impact assessment tools, and can be defined as "a process that directs decision making towards sustainability". Many methodological approaches were used to assess sustainability. All of these approaches use indicators as tools to generate relevant information. From the data they acquire a wide range of sources. To a large extent the effectiveness of the sustainability assessment depends on the robustness and rigor of the evaluation methodology. A research framework consisting of indicators and relevant criteria

and poorly defined can misinform and mislead policymakers [4, 5, 7]. Despite the relatively short history of the tools, evaluation of neighborhood sustainability (NSA = neighborhood sustainability assessment) has received considerable attention from the scientific community. Most studies have focused on the theoretical and unrealistic aspects [4, 5, 8]. In one of the few studies on this issue, Saynajoki et al. (2012) cited by [4] found that some of the indicators used in the NSA's tools are not relevant. Similar results were obtained in studies that [14] conducted respectively to examine the relevance of LEED-ND for use in England and Germany. This raises concerns that the results of these evaluations can mislead and misinform policymakers. Although there is still some controversy surrounding this issue, different tools have been used to assess the evolution of the neighborhood in several countries. For example LEED-ND has been used outside the United States and some countries of the European Community. BREEAM Communities has been used in several countries in the European Community. On the other hand, the CASBEE standard was used, from the beginning, within the country and only by some Japanese cities. After underutilization, this standard has found greater consideration in his country, through its development and its methodology. Now the Japanese government imposed the standard for all major projects. The non-use of CASBEE in other countries is due to its young age and also because the standard to be used needs qualified experts.

The Evolution of the Casbee-Ud Standard

The CASBEE certification standard was developed in 2004 by the Japan Sustainable Consortium (JSBC), involving committees in the academic, industrial and governmental sectors (Sev, 2011), and its family covers the housing scale of the building and the urban scale. CASBEE belongs to the category of assessment tools related to the built environment in order to assess the sustainability beyond a single building. CASBEE for urban development focuses on building-wide concepts of CASBEE. It is an independent certification assessment tool developed to help improve sustainability in town planning. CASBEE-UD uses not only building concepts, but also concepts related to the external environment of the entire site. The interior of the buildings is excluded by the evaluation. However, the family of products includes CASBEE "CASBEE urban area + Buildings", which allows the use of CASBEE-UD with assessment at the scale of the building (CASBEE for the urban development, 2007).

Weaknesses in Standards

The information available in the literature demonstrates that the tools need refinement. The most significant weaknesses found in standards and literature are: 1. The extent of sustainability (or sustainability); 2. The inclusion of prerequisites; 3. Adaptation to the locality; 4. The participation of stakeholders and citizens; 5. Placement of the actors in the project phases; 6. The presentation of results; 7. The application of the standard to different contexts.

The purpose of the sustainability assessment is to provide decision makers with a comprehensive and integrated local assessment system in the short and long-term prospects (LEED-ND, 2011 BREEAM Communities, 2009, CASBEE for Urban Development, 2007). Such a system would help them judge what actions should or should not be used in an attempt to create a more sustainable society [18]. For coverage of sustainability, developers can use a better sustainability approach while improving the resilience of neighborhoods through the provision of communities with strong local economy that are autonomous and have good infrastructure [14] [5]. These criteria are highlighted in a study on the relationship between urbanization and sustainable urbanization led by Oswald & McNeil, 2010; Waheed Khan, and. Veitch, 2009 cited by [18]. These criteria are important when addressing affordable housing to inclusive communities, social networks, mixed use, and the local economy. They improve the ability of an area to resist the various social and economic status regardless of their inhabitants. Therefore, the context-specific criteria should be included as well as the weights to be assigned to the values of the relevant specific communities. This could impose an additional economic burden on the developer, but it's the only way we can ensure the viability and reliability of the assessment results [5]. In terms of adaptation to the location, it was stressed that evaluation systems should vary depending on the type of development and also specific questions to the site. Other criticisms are the lack of citizen participation at the time of writing of the project, only because they are written by experts [14] [5]. The importance of the participation of different political and academic actors and the community during the various stages of planning is widely recognized by Khakee (1998) cited by [4]. By focusing on the inseparability of planning and evaluation, it suggests that the evaluation should be a discourse between all the actors who are somehow affected by the assessment, and should take the form of negotiations rather than pursuing a solution to a problem [14] [5]. Finally, citizens can participate by providing feedback that planners use for system update [14]. As for the use of such assessments, planners and developers can decide which changes are needed to bring the economic development activities in alignment with the ecological limits and social needs. The evaluation results can be potentially used by different stakeholders, including planners, designers, local authorities, the real estate market and residents. The central objective of most assessment tools is to act as a decision support tool [16]. The final results must provide an adequate and reliable picture of the situation on the ground. They have the potential to guide decisions for planning, guide the evaluation of actions and the degree of progress towards sustainable development and to educate residents. The results should be simple and transparent to avoid greenwashing and unfounded decisions. The results are analyzed to assess their ability to meet specified characteristics. BREEAM and LEED-ND Communities have a similar way of presenting the final results. The only difference between the two is that in BREEAM Communities, the projects that fail to acquire threshold points are also labelled. In most cases, certified projects receive a label based on the rankings they have achieved. CASBEE-UD, addressed, to some extent, deficiencies identified by presenting the results of each theme. In addition, there are scales (weak, good, very good, excellent) that can be used to highlight some performances [16], [5]. Although the tools are tailored to the priorities and conditions of their countries, the differences in climate parameters, social, and economic and type of developments are essential to make a customization of standards [14], [9, 10], [19]. However, this may not be possible due to various constraints. In such situations, the adopted standard should be

adapted and customized using benchmarks and appropriate weightings to be used as part of the assessment [14]. Due to significant changes in scope, planners should be aware that one size does not fit all. A personalized and customized tool with additional information is required for each development.

Sustainability Coverage

In urban and neighborhood contexts, where different forces and entities influence the decision-making process, it is essential to add the institutional dimension of the three pillars of sustainability [5]. The institutional dimension is not only the interactions between governmental and non-governmental organizations involved in decision-making, but also a set of norms, laws and regulations that interact with one another. Spangenberg (2002) cited by [5], argues this the institutional dimension also has the potential to facilitate links between the other dimensions and complement them. All evaluation standards seek to measure the degree of sustainability of cities or parts of them, and also the degree of sustainability performance of each project. The assessment themes, criteria and indicators used by certification standards are not common in urban assessment tools. Thus the need to briefly describe what is meant by terms like "theme", "criterion", and "indicator"; since these themes are the main subjects of concern for sustainability. Each theme contains one or more criteria that, as defined by Munier (2004) cited by [4], are "parameters used to assess the contribution of a project to achieve the required objective". Each criterion, in turn, has one or more indicators that are variables providing accurate measurements. This can be better explained by an example: "Resources and the environment is one of the main themes that include "energy" as a criterion that can be measured by indicators" [5]. Each standard presents a theme and for each theme there is a defined number of criteria. Each criterion is assigned a weight according to the relative importance it has within the sum of the criteria. These are percentages of the total number of indicators, regardless of the number of points awarded to each of them after the application of the weighting factor. Considering the CASBEE-UD standard, we can say that the weighting coefficients applied to the criteria and the percentage of maximum points available for the themes are different from LEED and BREEAM. For example, while in the LEED-ND assessment tool, 33% of the total number of criteria is related to the resource and environment theme, the points assigned to this set of criteria will generally add up to 18% of the total points available. Other LEED and BREEAM have included mixed use development criteria. In CASBEE-UD there are fewer social aspects, than in other tools. Only 6% of the CASBEE-UD criteria deal with social criteria and there are no criteria regarding affordable and social housing. Also the economic aspect is not taken into account by CASBEE-UD. All three standards considered are based on the principles of intelligent growth and include related criteria on development in filling, redevelopment of brownfields. The tools considered do not have any mechanism for assessing the performance of governmental and non-governmental institutions in the neighborhood. In addition, other key criteria such as governance, decentralization, legal frameworks and instruments, information systems, research and education to institutionalize sustainable development are also neglected. As tools evolve, institutional sustainability criteria are expected to be included in sustainability lists to address the issue of governance and the need for more efficient administrative procedures.

The Methodological Approach

In this first stage, the opportunity to engage citizens in an urbanization project and the use of certain methods to help communities develop a list of indicators will be discussed. This approach to decision making is primarily a political responsibility. It enables decision makers to explain and justify their choices and objectives to citizens. The methodology is planned in three steps (Figure A I-10-2). In the first step, an area will be selected in order to perform a statistical analysis of data.

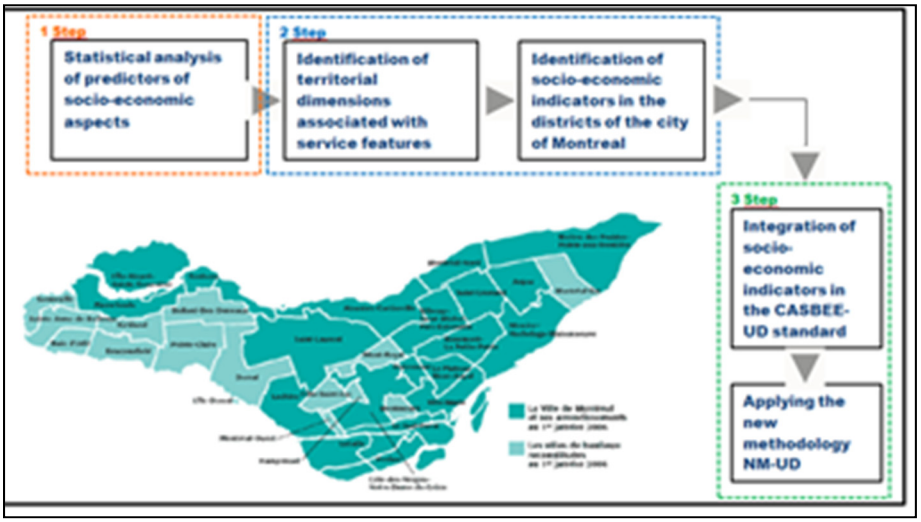

Figure-A I 7-2 - The Methodological Approach

With the statistical analysis, the independent variables of socio-economic aspects will be selected. In the second step, an analysis of the territory of each district to identify territorial dimensions (average distance of clinics, hospitals, public transportation, etc.) associated with the service functionality will be completed. In the same step, socio-economic and territorial indicators of each selected neighborhood will be identified. In the third step, socio-economic and territorial indicators will be integrated into the CASBEE-UD standard and the new standard will be applied to the selected territory.

First Step: Search for Independent Variables

At this stage, the criteria that have been selected are analyzed as applied to four districts of the City of Montreal to measure their degree of sustainability (Figure A I 10-3). We initially chose to take the data that had been used by the boroughs of Ahuntsic-Cartierville, Plateau Mont Royal, Sud-Ouest and Lachine to test the methodology through a statistical evaluation. The choice of these boroughs was made to collect data from each borough in order to obtain a wide range of samples. For this assessment a statistical analysis was used to research independent variables (see Table A I 10-5). After testing the results for these four boroughs,

the analysis will be extended to all boroughs of the City of Montreal in order for the assessment to be statistically representative.

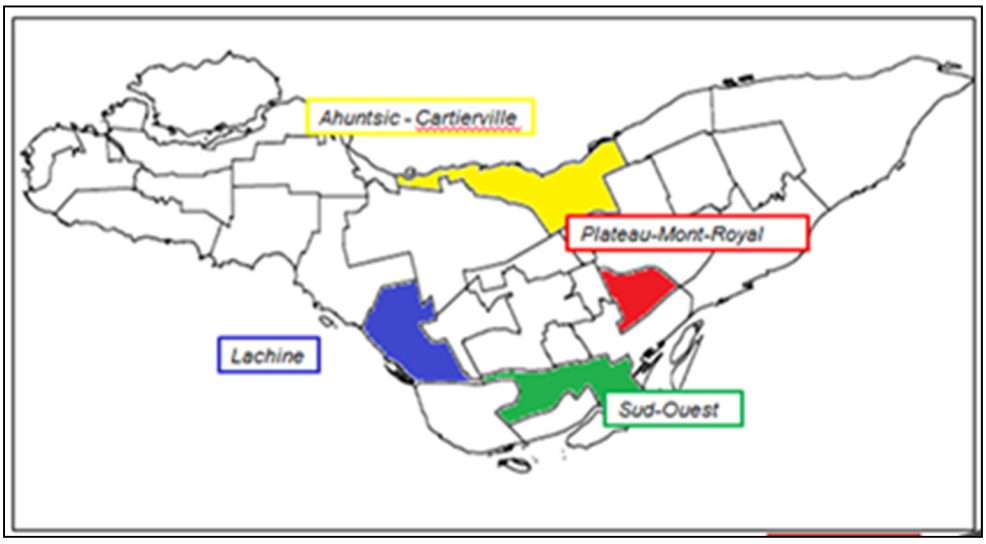

Figure-A I 7-3 - Choice of Boroughs being sampled

In this first stage, it was found that there are differences between the criteria selected by the standards and those used by the boroughs. To normalize the data, the equation was used to find the value for which our indices are to be divided. This statistical analysis gives the possibility of finding the weighting for each criterion.
These statistical analyses will meet the first objective of our research. In this first stage, it was noted that there is an absence of territorial criteria in the characterization of citizen satisfaction. So the next step in an analysis of the territory will be carried out to identify the missing criteria.

Table-A I 7-6- Independents Variables

	Thematic Field	Neighborhood Development Settings
Environmental Valuation	Natural Resource Management (Storm water, sewage, alternative energy, etc.), biodiversity, quality of natural areas	Infrastructure system water; Water consumption (including water quality);Energy consumption; Green spaces; Water surface; Vegetation
	Environmental protection (floodplains, rivers, lakes, wetlands, parks, animals, etc.)	Use of space; Living areas; Landscape (unnatural barrier, bridges, viaducts); Enhancing biodiversity; Morphology; River system
	Improved comfort and health (pollution of the site)	Ventilation; Physical comfort; Proportion of own sites; Soil quality; Lighting
Equitable Social Value/Social Responsibility	Strengthening cohesion and social equity	Accessibility; Public spaces; Density; Distribution services; Inclusion; Security
	Enhancement of the architectural (buildings and materials) and historical (preservation of historical memory) heritage	Structure; Materials; Technology; Protection; Care and maintenance; Form; Architectural fragmentation; Architectural quality
Economic Strategy	Cost reduction	Waste management; Distribution functions; Service – Business; Contiguity;
	Increase of cohesion (accessibility and transportation) and economic dynamics (employment and business)	Streets network; Public transport; Fluidity of movement; Parking; Links, connections; Economic diversification
	Multi-functionality of the territory, territorial competitiveness	Location; Connections; Partition areas; Urban form (urban fabric); Public areas; Historical activities

Second Step: The Location of the Essential Functions

To meet the second objective, that is considering the territorial dimension, the proposed approach will be based on the use of geographic information systems (GIS) to study urban form. GIS is composed of different layers of geographic reference information. This allows the user to combine the desired information and view it on a map (see Figure 3). A Multi-Criteria analysis model will be used to synthesize geographic information to select indicators satisfying citizens preferences. So the territorial dimensions will be identified to associate with the service capabilities across the GIS software for urban information and geographical shape.

This information will include criteria that are based on territorial characteristics and the location of critical functions essential to the quality of life of citizens. This approach was taken to represent the true diversity and distribution of the functions within the territory. In this approach, socio-economic and territorial indicators will be identified by way of a tool for decision support using a Multi-Criteria analysis method of hierarchical (Analytic Hierarchy Process (AHP)) (see Table A I 10-6).

Table-A I 7-7 - Prioritization of Territorial Indicators (Analytic Hierarchy Process or (AHP)

$$\frac{Vmax - Vmin}{X} + 1 = 9$$

OG	CR1	CR2	CR3	CR4	CR5	CR6	CR7	CR8	CR9	CR10	CR11	CR12
CR1	1	1,20	0,32	2,11	1,07	0,84	0,34	2,66	1,89	1,86	2,55	4,50
CR2		1	0,91	0,93	0,16	0,39	0,89	1,48	0,70	0,68	1,36	3,32
CR3			1	1,82	0,77	0,55	0,05	2,36	1,59	1,57	2,25	4,20
CR4				1	1,07	1,30	1,80	0,57	0,25	0,27	0,45	2,41
CR5					1	0,25	0,75	1,61	0,84	0,82	1,50	3,45
CR6						1	0,52	1,84	1,07	1,05	1,73	3,68
CR7							1	2,34	1,57	1,55	2,23	4,18
CR8								1	0,80	0,82	0,14	1,86
CR9									1	0,05	0,68	2,64
CR10										1	0,70	2,66
CR11											1	1,98
CR12												1

With this AHP method, it will be possible to determine the benefit-cost ratio of a project as to the advantages and disadvantages of its implementation that cannot be measured with money. All information is available both quantitatively and qualitatively. With this method, it is possible to handle problems dealing with qualitative data. This step will meet the second objective.

Step Three: Integration of Indicators and Application of the New Standard

The third step is structured in two parts. First, the socio-economic indicators identified will be included in the CASBEE-UD standard and this standard will be applied to the selected territory. The application of the new standard (CASBEE-UD new version) validates its power through the comparison between the selected standard and the new standard. The validation will be given either by the presence of socio-economic indicators, or through the use of a hierarchical approach to the decision that will compare the two methods of assessment and see the improvements. For a confrontation with targeted problems, this type of approach leads to innovative solutions, both through the application of certain technological developments by redefining the governance process (Figure A I 10-4). This creative dimension is integral to the philosophy of this type of project and often also a success factor for the field implementation of an increased number of sustainability criteria.

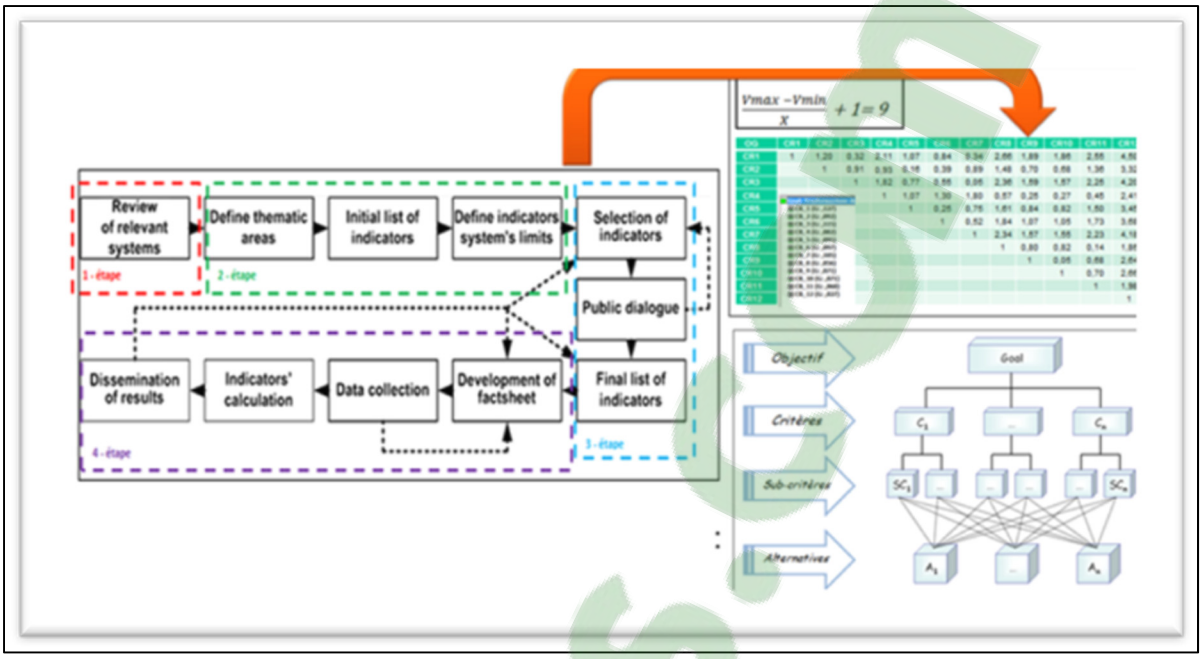

Figure-A I 7-4 - Process for Identifying the Final List of Indicators (Multi Criteria Approach)

Results

In the literature, we realize that certification standards are, however, looking for a common measure. It is important to ensure that all certification steps are measured in the same way to give a consistent message to the industry. The result of the study shows that CASBEE-UD with our socio-economic indicators is able to evaluate the project in the three dimensions of the sustainable development and with a higher number of points than before (Table-A I 6 7). This does mean adopting a universal certification system capable of evaluating projects of a similar nature. The results of the integration of the socio-economic aspects in CASBEE-UD is remarkable, because one can see on the radars that there are differences in the evaluation of the same territory.

Table-A I 7-8 - Integration Indicators in New CASBEE-UD Standard

Theme	Criteria	CASBEE-UD	New Standard
RESOURCES AND ENVIRONMENT	Energy, Materials, Biodiversity, Conservation, Resources, Water	41 points	30 points
TRANSPORTATION		10 points	10 points
SOCIAL	Affordable housing, Inclusive communities Safety, community well-being outreach, heritage, social networks	6 points	30 points
ECONOMIC	Local jobs, finances, investments, employment, business	0 points	10 points
LOCATION		3 points	20 points
PATTERN AND DESIGN	Mixed use, green infrastructure, compact development, access, urban planning and design	40 points	
INNOVATION	Accredited professionals Innovation	0 points	

On the radars on the left (see Figure A I 10-5 and Table A I 10-8), we can see the improvement on the norm in blue (CASBEE-UD without criteria) and in yellow (CASBEE-UD taking into account the integration socio-economic aspects).

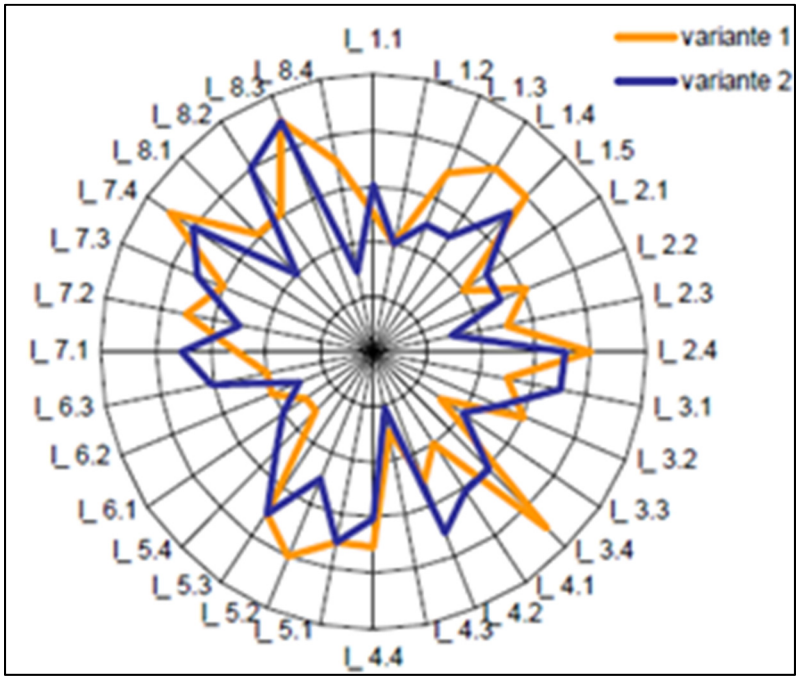

Figure-A I 7-5 Example of Scenario Analysis Result Form

Table-A I 7-9 - Example of Multi Criteria Evaluation Result Form Depicting Final Score of each Alternative

Dimensions	Base	Variante 1 (Casbee-UD)	Variante 2 (New Standard)
Environment	1.00	1.00	1.02
Use of space	1.00	0.96	1.01
Living areas	1.00	1.00	0.99
Landscape	1.00	0.94	1.05
Biodiversity	1.00	0.92	1.00
Morphology	1.00	1.15	1.00
River system	1.00	1.00	0.97
Social	1.00	1.02	1.00
Accessibility	1.00	1.00	0.97
Public spaces	1.00	1.00	0.87
Density	1.00	0.87	1.06
Distribution services	1.00	0.94	1.00
Inclusion	1.00	0.92	1.00
Security	1.00	0.82	0.92
Waste management	1.00	0.79	0.97
Distribution functions	1.00	0.67	1.01
Service – Business	1.00	0.52	1.04
Contiguity	1.00	0.89	0.86
Economic	1.00	0.0	1.00
Location	1.00	0.0	1.00
Connections	1.00	0.0	1.00
Partition areas	1.00	0.0	1.00
Urban form	1.00	0.0	1.00
Public areas	1.00	0.0	1.00
Historical activities	1.00	0.0	1.00

Discussion

A sustainable neighborhood should also be considered a closed system and turned in on itself. By its size and quality, it will add value to an urban area far beyond its physical boundaries. In the literature we realize that certification standards are, however, looking for a

common measure. It is important to ensure that all certification steps are measured in the same manner to give a consistent message to the industry. This does not mean adopting a universal certification system. Overall, the various systems have many differences. A rough comparison, carried out by researchers BREEAM, buildings with a score of "Platinum" (the highest) for LEED, reach a score lower in the ranking of BREEAM. In Europe, where the certification standards are more stringent than in the USA. Europe has also adopted the analysis of life cycle assessment (LCA) to a greater degree than in North America. In recent years, Japan, on the other hand, has developed innovative policies with respect to the state of its cities (Tokyo, Osaka). This is one reason why, in this study, the use of CASBEE-UD was chosen as a comparison standard. In its structure CASBEE-UD uses not only concepts linked to the building but also concepts related to the entire site's external environment. However, in this standard, the mainstreaming of social acceptability and identification of relevant indicators are not present. It is believed that the integration of these brings an improvement and a more concrete assistance in the design of a more sustainably built environment. We are of the opinion that this study is not comprehensive, but its structure is possible to highlight the fixed points that could help others seek to improve the structure of existing standards and make them independent of the interests of the Real Estate market which is oriented more towards labelling rather than take to heart the expectations of citizens.

LISTE DE RÉFÉRENCES BIBLIOGRAPHIQUES

Adams, D. , Watkins, C. and White, M. (2005) Planning, public policy and property markets: current relations and future challenges. In: Adams, D., Watkins, C. and White, M. (eds.) Planning, Public Policy and Property Markets. Wiley-Blackwell: Oxford, pp. 239-251. ISBN 9781405124300

AlQahtany, A., Rezgui, Y., & Li, H. (2013). A proposed model for sustainable urban planning development for environmentally friendly communities. Architectural Engineering and Design Management, 9(3), 176-194. doi: 10.1080/17452007.2012.738042

(Analyzing qualitative data -Bryan et Burgess 1994, 2 - Taylor & Francis e-Library, 2002 - ISBN 0-415-06062-1)

Anne Henry, « Un site urbain façonné par l'industrie : Thiers, ville coutelière », *In Situ*[En ligne], 6 | 2005, mis en ligne le 15 mai 2012, consulté le 09 juillet 2018. URL : http://journals.openedition.org/insitu/8588 ; DOI : 10.4000/insitu.8588

Bacot, H., & O'Dell, C. (2006). Establishing Indicators to Evaluate Brownfield Redevelopment. Economic Development Quarterly, 20(2), 142-161. doi: 10.1177/0891242405285749

Beekmans, J., Ploegmakers, H., Martens, K., & van der Krabben, E. (2015). Countering decline of industrial sites: Do local economic development policies target the neediest places? Urban Studies. doi: 10.1177/0042098015603289

Berardi, Umberto. 2012. "Sustainability Assessment in the Construction Sector: Rating Systems and Rated Buildings." Sustainable Development 20 (6): 411–424. doi: 10.1002/Sd.532.

Berardi, Umberto. 2013a. "Clarifying the New Interpretations of the Concept of Sustainable Building." Sustainable Cities and Society 8: 72–78. doi: 10.1016/j.scs.2013.01.008

Berardi, Umberto. 2013b. "Sustainability Assessment of Urban Communities through Rating Systems." Environment, Development and Sustainability 15(6):1573–1591.

Bond, Alan, Angus Morrison-Saunders, and Jenny Pope. 2012. "Sustainability Assessment: The State of the Art." Impact Assessment and Project Appraisal 30 (1): 53–62. doi: 10.1080/ 14615517.2012.661974.

Bramley, G., & Power, S. (2009). Urban Form and Social Sustainability: The Role of Density and Housing Type. Environment and Planning B: Planning and Design, 36(1), 30-48. doi: 10.1068/b33129

Brandt, U. S., & Svendsen, G. T. (2013). Is local participation always optimal for sustainable action? The costs of consensus-building in Local Agenda 21. Journal of Environmental Management, 129, 266-273. doi: http://dx.doi.org/10.1016/j.jenvman.2013.07.020

BREEAM, C. (2015). British organization BRE Global.

Brill, C. W. (2009). using GIS to contrast perceived versus preferred priorities for Brownfield redevelopment in worcester, massachusetts. URISA Journal, 21(2), 49.

Bureau, U. C. (2015). World Population. Repéré le 26 november 2017 à https://www.census.gov/popclock/

Burnett, J. (2007). City buildings—Eco-labels and shades of green! Landscape and Urban Planning, 83(1), 29-38. doi: http://dx.doi.org/10.1016/j.landurbplan.2007.09.003. Repéré à http://www.sciencedirect.com/science/article/pii/S0169204607002228

Cabernet. (2005).

CABERNET. (2017). Action on Brownfield and Economic Regeneration Network (CABERNET). Repéré à http://www.cabernet.org.uk

Cappai, F., Forgues, D., & Glaus, M. (2016). Integrating an environmental and Socio-economic assessment tool for the development of brownfield development projects Expanding Boundaries. doi: 10.3218/3774-6_99

Cappai, F., Forgues, D., & Glaus, M. (2018a). The Integration of Socio-Economic Indicators in the CASBEE-UD Evaluation System: A Case Study. Urban Science. 2018;2(1):28 DOI 10.3390/urbansci2010028

Cappai, F., Forgues, D., & Glaus, M. (2018b). Socio-Economic Indicators for the Ex-Post Evaluation of Brownfield Rehabilitation: A Case Study. Urban Science. 2018;2(4):100 DOI 10.3390/urbansci2040100

Cappuyns, V., Bouckenooghe, D., Van Breuseghem, L., & Van Herreweghe, S. (2011). J. Integr. Environ. Sci., 8(2), 103.

CASBEE-UD. (2014). IBEC Retrieved 09/11/2015, 2015, from http://www.ibec.or.jp/CASBEE/english/toolsE_urban.htm

Chang, N.-B., Parvathinathan, G., & Breeden, J. B. (2008). Combining GIS with fuzzy multicriteria decision-making for landfill siting in a fast-growing urban region. Journal of Environmental Management, 87(1), 139-153. doi: http://dx.doi.org/10.1016/j.jenvman.2007.01.011

Chen, Y., Hipel, K. W., Kilgour, D. M., & Zhu, Y. (2009). A strategic classification support system for brownfield redevelopment. Environmental Modelling & Software, 24(5), 647-654. doi: http://dx.doi.org/10.1016/j.envsoft.2008.10.011

Cheng, F., Geertman, S., Kuffer, M., & Zhan, Q. (2011). An integrative methodology to improve brownfield redevelopment planning in Chinese cities: A case study of Futian, Shenzhen. Computers, Environment and Urban Systems, 35(5), 388-398. doi: https://doi.org/10.1016/j.compenvurbsys.2011.05.007

Choguill, C. L. (2008). Developing sustainable neighbourhoods. Habitat International, 32(1), 41-48. doi: http://dx.doi.org/10.1016/j.habitatint.2007.06.007

Chrysochoou, M., Brown, K., Dahal, G., Granda-Carvajal, C., Segerson, K., Garrick, N., & Bagtzoglou, A. (2012). A GIS and indexing scheme to screen brownfields for area-wide redevelopment planning. Landscape and Urban Planning, 105(3), 187-198. doi: http://dx.doi.org/10.1016/j.landurbplan.2011.12.010

Chrysochoou, M., Garrick, N., Segerson, K., Bagtzoglou, A., Dahal, G., Brown, K., & Granda-Carvajal, C. (2011). Reversing urban sprawl: A reclaimability index approach for reviving downtown Brownfields. No. CTLS, 08-03.

Cities Alliance. (2007).

Clark, W. W. (2010). Sustainable Communities Design Handbook: Green Engineering, Architecture, and Technology (W. W. Clark Ed.).

Corbetta Piergiorgio - Metodologia e tecniche della ricerca sociale - Editore: Il Mulino Collana: Strumenti Anno edizione: 1999 In commercio dal: 26/02/1999 Pagine: 656 p. EAN: 9788815067920)

Cohen, A. (2010). Achieving Healthy School Siting and Planning Policies: Understanding Shared Concerns of Environmental Planners, Public Health Professionals, and Educators. NEW SOLUTIONS: A Journal of Environmental and Occupational Health Policy, 20(1), 49-72. doi: 10.2190/NS.20.1.d

Coulton, C. J., Jennings, M. Z., & Chan, T. (2013). How Big is My Neighborhood? Individual and Contextual Effects on Perceptions of Neighborhood Scale. American Journal of Community Psychology, 51(1), 140-150. doi: 10.1007/s10464-012-9550-6

Cundy, A. B., Bardos, R. P., Church, A., Puschenreiter, M., Friesl-Hanl, W., Müller, I., . . . Vangronsveld, J. (2013). Developing principles of sustainability and stakeholder engagement for "gentle" remediation approaches: The European context. Journal of Environmental Management, 129, 283-291. doi: http://dx.doi.org/10.1016/j.jenvman.2013.07.032

DA CUNHA A., MATTHEY L. (coords.), 2007, La ville et l'urbain : des savoirs émergents, Lausanne, Presses polytechniques et universitaires romandes, 488 p.

Daily, G. C., Polasky, S., Goldstein, J., Kareiva, P. M., Mooney, H. A., Pejchar, L., ... Shallenberger, R. (2009). Ecosystem services in decision making: Time to deliver. Frontiers in Ecology and the Environment, 7(1), 21-28. https://doi.org/10.1890/080025

Deshayes, P. (2012). Le secteur du bâtiment face aux enjeux du développement durable : logiques d'innovation et/ou problématiques du changement. Innovations, 37,(1), 219-236. doi:10.3917/inno.037.0219.

De Sousa, C. A. (2003). Turning brownfields into green space in the City of Toronto. Landscape and Urban Planning, 62(4), 181-198. doi: http://dx.doi.org/10.1016/S0169-2046(02)00149-4

De Sousa, C. A. (2006). Urban brownfields redevelopment in Canada: the role of local government. Canadian Geographer / Le Géographe canadien, 50(3), 392-407. doi: 10.1111/j.1541-0064.2006.00148.x

EPA, U. (2004). United States Environmental Protection Agency

Ewing, R., Hamidi, S., Grace, J. B., & Wei, Y. D. (2016). Does urban sprawl hold down upward mobility? Landscape and Urban Planning, 148, 80-88. doi: https://doi.org/10.1016/j.landurbplan.2015.11.012

Gilles Bentayou et Bilel Benbouzid, « L'urbanisme et ses études. Réflexions à partir de deux exemples de politiques d'aménagement urbain à Lyon », Histoire & mesure [En ligne], XXIV-2 | 2009, mis en ligne le 31 décembre 2009, consulté le 26 juin 2018. URL : http://journals.openedition.org/histoiremesure/3961 ; DOI : 10.4000/histoiremesure.3961

George, G. (2001). On the Nature of Neighbourhood. Urban Studies, 38(12), 2111-2124. doi: 10.1080/00420980120087072

Giaccone, A., Lascari, G., Peri, G., & Rizzo, G. (2017). An ex post criticism, based on stakeholders' preferences, of a residential sector's energy master plan: the case study of the Sicilian region. Energy Efficiency, 10(1), 129-149. doi: 10.1007/s12053-016-9444-9

Gómez-Baggethun, E., & Barton, D. N. (2013). Classifying and valuing ecosystem services for urban planning. Ecological Economics, 86, 235-245. doi: https://doi.org/10.1016/j.ecolecon.2012.08.019

Gravel, F. (2012). La Revitalisation de Pointe-Saint-Charles à Montréal: Un cas de Transformation des Quartiers Ouvriers Péricentraux. Université de Québec à Montréal: Montréal, QC, USA, 174.

Greenberg, M., & Lewis, M. J. (2000). Brownfields Redevelopment, Preferences and Public Involvement: A Case Study of an Ethnically Mixed Neighbourhood. Urban Studies, 37(13), 2501-2514. doi: 10.1080/00420980020080661

Gustavson, K. R., Lonergan, S. C., & Ruitenbeek, H. J. (1999). Selection and modeling of sustainable development indicators: a case study of the Fraser River Basin, British Columbia. Ecological Economics, 28(1), 117-132. doi: https://doi.org/10.1016/S0921-8009(98)00032-9

Haapio, A. (2012). Towards sustainable urban communities. Environmental Impact Assessment Review, 32(1), 165-169. doi: https://doi.org/10.1016/j.eiar.2011.08.002

Hernández, B., Carmen Hidalgo, M., Salazar-Laplace, M. E., & Hess, S. (2007). Place attachment and place identity in natives and non-natives. Journal of Environmental Psychology, 27(4), 310-319. doi: https://doi.org/10.1016/j.jenvp.2007.06.003

Hiremath, R. B., Balachandra, P., Kumar, B., Bansode, S. S., & Murali, J. (2013). Indicator-based urban sustainability—A review. Energy for Sustainable Development, 17(6), 555-563. doi: https://doi.org/10.1016/j.esd.2013.08.004

Holden, M. (2013). Sustainability indicator systems within urban governance: Usability analysis of sustainability indicator systems as boundary objects. Ecological Indicators, 32, 89-96. doi: http://dx.doi.org/10.1016/j.ecolind.2013.03.007

Hyra, D. (2015). The back-to-the-city movement: Neighbourhood redevelopment and processes of political and cultural displacement. Urban Studies, 52(10), 1753-1773. doi: 10.1177/0042098014539403

Hyra, D. S. (2012). Conceptualizing the New Urban Renewal:Comparing the Past to the Present. Urban Affairs Review, 48(4), 498-527. doi: 10.1177/1078087411434905

Inoue, Y., & Katayama, A. (2004). J. Mater. Cycles Waste Manag., 6(null), 48.

Inoue, Y., & Katayama, A. (2011). J Hazard Mater., 192(3), 1234.

Johnson, J. K., & Whitlam, G. B. (1988). Estimation and interpretation problems in the ex post economic analysis of projects. Project Appraisal, 3(4), 219-228. doi: 10.1080/02688867.1988.9726692

Kaufman, D. A., & Cloutier, N. R. (2006). The Impact of Small Brownfields and Greenspaces on Residential Property Values. The Journal of Real Estate Finance and Economics, 33(1), 19-30. doi: 10.1007/s11146-006-8272-7

Kepaptsoglou, K., Karlaftis, M. G., Gkotsis, I., Vlahogianni, E., & Stathopoulos, A. (2015). Urban Regeneration in Historic Downtown Areas: An Ex-Ante Evaluation of Traffic Impacts in Athens, Greece. International Journal of Sustainable Transportation, 9(7), 478-489. doi: 10.1080/15568318.2013.811331

Kyrkou, Dimitra and Roland Karthaus. 2011. "Urban sustainability standards: predetermined checklists or adaptable frameworks?". Procedia Engineering, vol. 21, no 0, p. 204-211. doi: doi.org/10.1016/j.proeng.2011.11.2005

Lange, D., & McNeil, S. (2004). Clean It and They Will Come? Defining Successful Brownfield Development. Journal of Urban Planning and Development, 130(2), 101-108. doi: doi:10.1061/(ASCE)0733-9488(2004)130:2(101)

LEED-ND. (2015). Green Building Council in the US. Retrieved 16/11/2015, 2015, from http://www.usgbc.org/resources/leed-v4- neighborhood-development- current-version

Luederitz, C., Lang, D. J., & Von Wehrden, H. (2013). A systematic review of guiding principles for sustainable urban neighborhood development. Landscape and Urban Planning, 118(Supplement C), 40-52. doi: https://doi.org/10.1016/j.landurbplan.2013.06.002

Levett, R. (1998). Sustainability indicators-integrating quality of life and environmental protection. Journal of the Royal Statistical Society: Series A (Statistics in Society), 10/1998, Vol.161(3), pp.291-302. doi: https://rss.onlinelibrary.wiley.com/doi/full/10.1111/1467-985X.00109

Maisons en bois–Canada–Conception et construction. 2. Bâtiments à ossature de bois–Canada–Conception et construction. 3. Habitations–Construction–Canada. I. Société canadienne d'hypothèques et de logement II. Titre. TH4818.W6B87 2005 694 C2005-980263-4 - ISBN 0-660-19535-6- © 1967 Société canadienne d'hypothèques et de logement - Troisième édition comprenant les unités impériales et métriques Révision et réimpression : 2013

Marsal-Llacuna, M.-L., & Segal, M. E. (2017). The Intelligenter Method (II) for "smarter" urban policy-making and regulation drafting. Cities, 61(Supplement C), 83-95. doi: https://doi.org/10.1016/j.cities.2016.05.006

Mathieu, P.-H. (2011). Pour une Approche Urbanistique de la Conservation et de la Mise en Valeur du Patrimoine Bâti: L'expérience du Canal de Lachine à Montréal. (Ph.D.), Université de Montréal, Montréal QC, Canada.

Meijer, A. J., Curtin, D., & Hillebrandt, M. (2012). Open government: connecting vision and voice. International Review of Administrative Sciences, 78(1), 10-29. doi: 10.1177/0020852311429533

Mori, K., & Christodoulou, A. (2012). Review of sustainability indices and indicators: Towards a new City Sustainability Index (CSI). Environmental Impact Assessment Review, 32(1), 94-106. doi: http://dx.doi.org/10.1016/j.eiar.2011.06.001

Moussiopoulos, N., Achillas, C., Vlachokostas, C., Spyridi, D., & Nikolaou, K. (2010). Environmental, social and economic information management for the evaluation of sustainability in urban areas: A system of indicators for Thessaloniki, Greece. Cities, 27(5), 377-384. doi: http://dx.doi.org/10.1016/j.cities.2010.06.001

Ng, M. K., Cook, A., & Chui, E. W. T. (2001). The Road Not Travelled: A Sustainable Urban Regeneration Strategy for Hong Kong. Planning Practice & Research, 16(2), 171-183. doi: 10.1080/02697450120077370

Nijkamp, P., Rodenburg, C. A., & Wagtendonk, A. J. (2002). Success factors for sustainable urban brownfield development: A comparative case study approach to polluted sites. Ecological Economics, 40(2), 235-252. doi: http://dx.doi.org/10.1016/S0921-8009(01)00256-7

NRTEE. (2003). The National Round Table on the Environment and the Economy (NRTEE): Expanded Decision-making for Sustainable Development. National Round Table on the Environment and the Economy.

Pediaditi, K., Doick, K. J., & Moffat, A. J. (2010). Monitoring and evaluation practice for brownfield, regeneration to greenspace initiatives: A meta-evaluation of assessment and monitoring tools. Landscape and Urban Planning, 97(1), 22-36. doi: http://doi.org/10.1016/j.landurbplan.2010.04.007

Préfontaine, É. (2008). Effets mesurés de la réhabilitation des friches industrielles : transformations de la qualité de vie et des valeurs foncières de trois sites dans le sud-ouest de montréal (I. n. d. l. r. scientifique Ed.).

Publisher, N. A. Q. O. (2017). An Act to amend the Environment Quality Act and other legislative provisions with regard to land protection and rehabilitation. Retrieved 12 September 2018, 2018, from http://www2.publicationsduquebec.gouv.qc.ca/dynamicSearch/telecharge.php?type=5&file=2002C11A.PDF

Rall, E. L., & Haase, D. (2011). Creative intervention in a dynamic city: A sustainability assessment of an interim use strategy for brownfields in Leipzig, Germany. Landscape and Urban Planning, 100(3), 189-201. doi: http://dx.doi.org/10.1016/j.landurbplan.2010.12.004

Rees, W., & Wackernagel, M. (1996). Urban ecological footprints: Why cities cannot be sustainable—And why they are a key to sustainability. Environmental Impact Assessment Review, 16(4–6), 223-248. doi: http://dx.doi.org/10.1016/S0195-9255(96)00022-4

RESO. (2002). 48.50. Regroupement économique et social du Sud-Ouest Retrieved 23 Mars 2015, 2015, from https://www.arrondissement.com/montreal/regroupementeconomiqueetsocialdusudouestreso, visité le 14/05/2016

Robert K. Yin. (2014). Case Study Research Design and Methods (5th ed.). Thousand Oaks, CA: Sage. 282 pages. Vol 30, No 1 (2015) ISSN: 1496-7308

Roberts, P. (2006). Evaluating regional sustainable development: Approaches, methods and the politics of analysis. Journal of Environmental Planning & Management, 49(4), 515-532. doi: 10.1080/09640560600747786

Sahely, H. R., Kennedy, C. A., & Adams, B. J. (2005). Developing sustainability criteria for urban infrastructure systems. Canadian Journal of Civil Engineering, 32(1), 72-85. doi: 10.1139/l04-072

Sardinha, I. D., Craveiro, D., & Milheiras, S. (2013). A sustainability framework for redevelopment of rural brownfields: stakeholder participation at SÃO DOMINGOS mine, Portugal. Journal of Cleaner Production, 57, 200-208. doi: http://dx.doi.org/10.1016/j.jclepro.2013.05.042

SBTool, G. S. a. (2004).

Schädler, S., Morio, M., Bartke, S., Rohr-Zänker, R., & Finkel, M. (2011). Designing sustainable and economically attractive brownfield revitalization options using an integrated assessment model. Journal of Environmental Management, 92(3), 827-837. doi: http://dx.doi.org/10.1016/j.jenvman.2010.10.026

Schulze Bäing, A., & Wong, C. (2012). Brownfield Residential Development: What Happens to the Most Deprived Neighbourhoods in England? Urban Studies, 49(14), 2989-3008. doi: 10.1177/0042098012439108

Scipioni, A., Mazzi, A., Mason, M., & Manzardo, A. (2009). The Dashboard of Sustainability to measure the local urban sustainable development: The case study of Padua Municipality. Ecological Indicators, 9(2), 364-380. doi: https://doi.org/10.1016/j.ecolind.2008.05.002

Secretariat, G. o. C.-T. B. o. C. (2018). Federal Contaminated Sites Inventory Retrieved 4 october 2018, 2018, from https://www.tbs-sct.gc.ca/fcsi-rscf/home-accueil-eng.aspx

Sev, A. (2011). A comparative analysis of building environmental assessment tools and suggestions for regional adaptations. Civil Engineering and Environmental Systems, 28(3), 231-245. doi: 10.1080/10286608.2011.588327

Sharifi, A. (2016). From Garden City to Eco-urbanism: The quest for sustainable neighborhood development. Sustainable Cities and Society, 20(Supplement C), 1-16. doi: https://doi.org/10.1016/j.scs.2015.09.002

Sharifi, A., & Murayama, A. (2013). A critical review of seven selected neighborhood sustainability assessment tools. Environmental Impact Assessment Review, 38, 73-87. doi: http://dx.doi.org/10.1016/j.eiar.2012.06.006

Sharifi, A., & Murayama, A. (2015). Viability of using global standards for neighbourhood sustainability assessment: insights from a comparative case study. Journal of Environmental Planning & Management, 58(1), 1-23. doi: 10.1080/09640568.2013.866077

Shen, L., Peng, Y., Zhang, X., & Wu, Y. (2012). An alternative model for evaluating sustainable urbanization. Cities, 29(1), 32-39. doi: http://dx.doi.org/10.1016/j.cities.2011.06.008

Steigemann, A. M. (2010). The New Urban Renewal: The Economic Transformation of Harlem and Bronzeville – By Derek S. Hyra. International Journal of Urban and Regional Research, 34(3), 717-719. doi: doi:10.1111/j.1468-2427.2010.00990_5.x

Suzer, O. (2015). A comparative review of environmental concern prioritization: LEED vs other major certification systems. Journal of Environmental Management, 154, 266-283. doi: http://dx.doi.org/10.1016/j.jenvman.2015.02.029

Talen, E., Allen, E., Bosse, A., Ahmann, J., Koschinsky, J., Wentz, E., & Anselin, L. (2013). LEED-ND as an urban metric. Landscape and Urban Planning, 119, 20-34. doi: http://dx.doi.org/10.1016/j.landurbplan.2013.06.008

Tanguay, G. A., Rajaonson, J., Lefebvre, J.-F., & Lanoie, P. (2010). Measuring the sustainability of cities: An analysis of the use of local indicators. Ecological Indicators, 10(2), 407-418. doi: http://dx.doi.org/10.1016/j.ecolind.2009.07.013

Thomas, M. R. (2002a). A GIS-based decision support system for brownfield redevelopment. Landscape and Urban Planning, 58(1), 7-23. doi: http://dx.doi.org/10.1016/S0169-2046(01)00229-8

Thomas, M. R. (2002b). A Weighted, Multi-Attribute, Site Prioritization and Selection Process for Brownfield Redevelopment. Environmental Practice, 4(02), 95-106. doi: doi:10.1017/S1466046602021105

Thomas, M. R. (2003). The use of ecologically based screening criteria in a community-sponsored open space preservation programme. Journal of Environmental Planning and Management, 46(5), 691-714.

Thornton, G., Franz, M., Edwards, D., Pahlen, G., & Nathanail, P. (2007). The challenge of sustainability: incentives for brownfield regeneration in Europe. Environmental Science & Policy, 10(2), 116-134. doi: http://dx.doi.org/10.1016/j.envsci.2006.08.008

Tonin, S. (2014). Assessing the impact of the remedial actions taken at a contaminated Italian site: an ex-post valuation analysis. Reviews in Environmental Science and Bio/Technology, 13(2), 121-137. doi: 10.1007/s11157-014-9332-8

Turcu, C. (2013). Re-thinking sustainability indicators: local perspectives of urban sustainability. Journal of Environmental Planning and Management, 56(5), 695-719. doi: 10.1080/09640568.2012.698984

Veron, J. (2006). « L'urbanisation du monde », Alternatives internationales, 32 :128

Wackernagel, M., & Rees, W. (1998). Our ecological footprint: reducing human impact on the earth (Vol. 9): New Society Publishers.

Wedding, G. C., & Crawford-Brown, D. (2007). Measuring site-level success in brownfield redevelopments: A focus on sustainability and green building. Journal of Environmental Management, 85(2), 483-495. doi: http://dx.doi.org/10.1016/j.jenvman.2006.10.018

Wiel, Marc. (2000). La transition urbaine, ou le Passage de la ville pédestre à la ville motorisée, 2000, Bruxelles, Mardaga, 150 p.

Wong, S.-C., & Abe, N. (2014). Stakeholders' perspectives of a building environmental assessment method: The case of CASBEE. Building and Environment, 82, 502-516. doi: https://doi.org/10.1016/j.buildenv.2014.09.007

Yu, S., Unger, A. J. A., Parker, B., & Kim, T. (2012). Allocating risk capital for a brownfields redevelopment project under hydrogeological and financial uncertainty. Journal of Environmental Management, 100, 96-108. doi: http://dx.doi.org/10.1016/j.jenvman.2012.01.020. Repéré à http://www.sciencedirect.com/science/article/pii/S030147971200028X

https://www.epa.gov/, visité le 24/05/2018].

https://donnees.banquemondiale.org/indicateur/SP.POP.TOTL visité le 10/07/2018

http://ville.montreal.qc.ca/portal/page?_pageid=7237,74689587&_dad=portal&_schema=PORTAL visité le 10/07/2018, visité le 23/04/2016

Zimmermann, J. A. M., & Stevens, B. W. (2006). The use of performance measurement in South Carolina nonprofits. Nonprofit Management and Leadership, 16(3), 315-327. doi: doi:10.1002/nml.109

Smart City & Mobility Lab, 2017, http://www.marcodemitri.it/smart-city-citta-intelligenti/), visité le 09/09/2017