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MUNICIPAL PRACTICES AND NEEDS REGARDING ACCESSIBILITY OF PEDESTRIAN INFRASTRUCTURES FOR INDIVIDUALS WITH PHYSICAL DISABILITIES IN QUÉBEC, CANADA

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***Abstract*:** To create enabling environments for as many individuals as possible, including individuals with physical disabilities (IPD) who are more prone to encounter environmental barriers limiting their social participation, we need to examine current municipal practices related to accessibility. The objectives of this study were to describe existing practices supporting the design of accessible pedestrian infrastructures (API) for IPD living in Quebec (Canada), as well as to identify the perceived informational needs of the municipalities to design such infrastructures. A WEB survey was developed and validated by experts (i.e., municipal/provincial entities, IPD advocacy organisations, public transportation society, and researchers) and was sent to 507 municipalities. Descriptive statistics and recursive partitioning were performed, which allowed for the analysis of predictive variables through an arborescence (e.g. the characteristics of the municipality that predict the implementation of various accessible design practices). A total of 186 respondents (representatives of 184 of 507 municipalities) completed the survey (37%). Few municipalities have measures, resources, and tools to ensure the design of API for IPD. However, many respondents perceived the need for such resources. The presence of an

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action plan for individuals with visual disabilities and their consultation, availability of human resources, and knowledge of tools for the design of API favor the implementation of other accessibility practices and should be targeted to favor the presence of accessibility practices. Results of this study highlighted the need for conceptualization and implementation of guidelines to ensure API, and identified potential measures to improve practices that favor social participation of IPD.

Keywords: Pedestrian infrastructures, accessibility, physical disabilities, survey, municipal practices.

Introduction

For individuals with physical disabilities (IPD), environmental barriers or facilitators can make a difference between handicap situations and social participation. (P. Fougeyrollas et al., 2014) As mapped out in the *Human development model - Disability creation process* (HDM-DCP), the interaction between personal factors (identity factors, organic systems, capabilities), environmental factors (social and physical, considered either as facilitators or obstacles at various scales (micro, meso, macro)) as well as life habits (daily activities and social roles) constitute the interacting elements resulting in a handicap situation or social participation depending on the level of adequacy and of congruence between these factors. (Patrick Fougeyrollas, 2010) To ensure access to the built environment (a critical component in the interaction for social participation), standards, and practices in place need to reinforce the need of IPD. To create enabling environments for as many individuals as possible, including IPD who are more prone to encounter barriers, we need a systematic assessment of what municipalities do to favour accessibility. As of now, no literature describes the practices in Quebec's municipalities regarding the level of accessibility of pedestrian infrastructures. Some authors have studied walkability in Canada but not specifically for IPD. Walkability was mostly explored for older adults (Chaudhury, Campo, Michael, & Mahmood, 2016; Grant, Edwards, Sveistrup, Andrew, & Egan, 2010; Mitra, Siva, & Kehler, 2015; Negron-Poblete & Lord, 2014) and able-bodied individuals (Clark & Scott, 2016; Hajna, Ross, Joseph, Harper, & Dasgupta, 2015; McCormack et al., 2012; Thielman, Rosella, Copes, Lebenbaum, & Manson, 2015) and not really in terms of

accessibility but of connectivity to destinations (Chaudhury et al., 2016; Grant et al., 2010; Hajna et al., 2015; Mitra et al., 2015; Negron-Poblete & Lord, 2014), traffic(Grant et al., 2010), subjective appreciation of the neighborhood (Chaudhury et al., 2016; Grant et al., 2010; Mitra et al., 2015; Negron-Poblete & Lord, 2014) and physical activity (de Sa & Ardern, 2014; Hajna et al., 2015; McCormack et al., 2012; Mitra et al., 2015; Thielman et al., 2015). Since Quebec (Canada) is a northern province with particular climatic conditions, and that municipal practices and governance are of great importance in the implementation of accessibility practices, knowing what are the current practices and desires of municipalities in Quebec's context is of prime importance as a first step to improve existing practices for the benefit of IPD.

The literature shows that IPD experience many obstacles related to pedestrian infrastructures, such as curb cuts (e.g., absence of (Gray, Hollingsworth, Stark, & Morgan, 2008; Hoehner, Ivy, Ramirez, Handy, & Brownson, 2007; Kirchner, Gerber, & Smith, 2008; Millington et al., 2009), abruptness (Bennett, Kirby, & Macdonald, 2009; Kerr & Rosenberg, 2009), height (Bennett et al., 2009; Cunningham, Michael, Farquhar, & Lapidus, 2005; Spivock, Gauvin, & Brodeur, 2007)), sidewalks (absence of (Clifton, Livi Smith, & Rodriguez, 2007; Hoehner et al., 2007; Kerr & Rosenberg, 2009; Lee, Tudor-Locke, & Burns, 2008), narrow or cluttered (Clifton et al., 2007; Hoehner et al., 2007; Kerr & Rosenberg, 2009; Kirchner et al., 2008; Lee et al., 2008; Millington et al., 2009; Spivock et al., 2007)), the lack of drainage or uneven surfaces (Clifton et al., 2007; Gray et al., 2008; Kerr & Rosenberg, 2009; Keysor et al., 2010; Kirchner et al., 2008; Lee et al., 2008; Millington et al., 2009; Spivock et al., 2007), the lack of maintenance and snow removal (Kirchner et al., 2008; Spivock et al., 2007), crosswalks (absence of (Clifton et al., 2007; Hoehner et al., 2007; Kerr & Rosenberg, 2009; Kirchner et al., 2008; Lee et al., 2008), insufficient crossing time (Kerr & Rosenberg, 2009; Spivock et al., 2007), absence of audible (Spivock et al., 2007) and visual (Clifton et al., 2007; Hoehner et al., 2007; Kerr & Rosenberg, 2009; Lee et al., 2008; Millington et al., 2009; Spivock et al., 2007) cues), the lack of lighting (Clifton et al., 2007; Kirchner et al., 2008; Lee et al., 2008; Millington et al., 2009), the presence of steps or stairs in the pedestrian area (Giesbrecht, Ripat, Cooper, & Quanbury, 2011; Kerr & Rosenberg, 2009), inadequate topography (Clifton et al., 2007; Kerr & Rosenberg, 2009; Kirchner et al., 2008), the absence of rest areas or of benches

(Hoehner et al., 2007; Keysor et al., 2010) or inaccessible bus stops (Hoehner et al., 2007; Keysor et al., 2010; Spivock et al., 2007). Environmental inaccessibility can lead to negative social, emotional and financial consequences for IPD (Cooper, Cohen, & Hasselkus, 1991; Deliot-Lefevre, 2006; Law, 1991; McClain, Medrano, Marcum, & Schukar, 2000; Shumway-Cook et al., 2005; Tranter, Slater, & Vaughan, 1991). High social costs can be entailed by the inaccessibility of pedestrian infrastructures, namely for physical and mental health treatment related to diminished productivity related to the lack of activity, social interactions, confinement, and degradation of health status (Brownson, Hoehner, Day, Forsyth, & Sallis, 2009; Cooper et al., 1991).

Although environmental barriers can reduce accessibility, elicit additional costs, and pose safety concerns, there is no consensus on the necessary characteristics that pedestrian infrastructures should possess to ensure efficient and safe mobility for IPD. Therefore, to reduce the occurrence of environmental obstacles, and ultimately improve municipal practices related to accessibility, an analysis of current practices in municipalities is required. With the rising of movements encouraging sustainable development, intelligent cities, and efficient urban planning, the consideration of IPD should be of the outmost importance since it is part of a larger process to improve infrastructures for all which contributes to the improvement of practices in general. Thus, the objectives of this study were to describe existing supporting practices for the design of accessible pedestrian infrastructures for IPD in Quebec's municipalities (Canada), and to identify perceived needs (e.g., information for municipalities to design accessible infrastructures).

Methodology

Approach

Quebec's Ministry of Transportation identified the need to provide tools to smaller municipalities (<15,000 inhabitants) to help them ensure accessibility of the built environment for individuals with physical disabilities who encounter a greater number of barriers outside their home. Thus, to propose solutions to these municipalities and to identify good applicable practices within this context, Quebec's municipalities were targeted. This study is part of a larger project based on a partnership and participative approach (Ivey & Sanders, 2006; Morales, Rousseau, & Passini, 2015; Sanders & Stappers, 2008) between experts in the fields of accessibility, IPD and pedestrian infrastructures. The objective of this larger project is to identify appropriate design practices of pedestrian infrastructures for IPD. Two committees were created: 1) a leading committee (follow up on the project's calendar and methodologies used) and 2) a consultative committee (to encourage sharing of the experts' knowledge throughout the different steps of the project to ensure that all is done to attain the goals set by the leading committee). These committees had representatives from the same organisations, but in different numbers. These organisations were: Quebec's Ministry of Transportation (*ministère des Transports du Québec*) (n=4), municipality of Quebec City (n=1), community organizations representing IPD (*Confédération des organismes de personnes handicapées du Québec* and *Regroupement des organismes de personnes handicapées de la région 03* (n=2), a government agency defending the rights of IPD (*Office des personnes handicapées du Québec*) (n=1), groups representing Quebec's municipalities (*Union des municipalités du Québec* and *Fédération québécoise des municipalités*) (n=2), and a public transportation service (*Réseau de transport de la Capitale*) (n=1).

Design and validation of the survey

A WEB survey (de Leeuw, Jox, & Dillman, 2008; Dillman, 2000; Sue & Ritter, 2007) was created to investigate practices and perceived information needs of municipalities of different densities in Quebec with regards to the design of accessible pedestrian

infrastructures for IPD. A first draft was developed by the research team (seven researchers in the fields of rehabilitation, engineering, geography, sociology, mobility, architecture, social participation, occupational therapy) according to their experiential knowledge of accessibility practices in the design of pedestrian infrastructures and municipal practices. To our best knowledge, similar surveys or literature have not been documented. The content was then reviewed by the leading and the consultative committees. Taking into account the proposed modifications, the research team reviewed and refined the content of the WEB survey. The survey was created in an online format using *FluidSurvey* and pre-tested with three representatives of municipalities of different densities. Pre-tests were think-aloud cognitive interviews (Dillman, 2000) where respondents were instructed to say everything that came to mind aloud (comments/interpretations) while answering the survey.

Structure of the survey

The structure of the survey (contents of interest) is summarized here.

1. Municipality
    a. Number of inhabitants
2. Respondent
    a. Type of professional training
    b. Training domain
    c. Work title
3. Action plan
    a. Is there one and for whom
4. Responsible for accessibility
    a. Work load
    b. Work title
5. Hiring

    a. Knowledge of accessibility as a prerequisite

6. Associations
    a. Member of associations favouring access
7. Training
    a. Activities on accessibility
    b. Targeted work titles
    c. Type of activities
    d. Targeted subjects
8. Tools to design accessible pedestrian infrastructures
    a. Knows tools
    b. Tools used
    c. Advantages of the tools used
    d. Disadvantages of the tools used
9. Human resources
    a. Municipality
    b. Use of external resources (for which type of pedestrian infrastructure, work title, use of interventions and why)
10. Citizens' consultation
    a. Groups consulted
11. Particular practices
    a. Regarding pedestrian infrastructures and climate
12. Chose three factors influencing the most the implantation of accessibility
    a. Costs

b. Availability of expertise

c. Human resources

d. Material resources

e. Time

f. Topographic configuration

13. Importance of accessible pedestrian infrastructures

a. Curb cuts

b. Curbs

c. Tactile paving

d. Drainage grates

e. Lighting

f. Audible cues

g. Crossing islands

h. Urban furniture

i. Signage and traffic lights

j. Crosswalks

k. Sidewalks

Only for municipalities of less than 15,000 inhabitants

14. Pedestrian infrastructures present

a. Curb cuts

b. Curbs

c. Tactile paving

d. Drainage grates

e. Lighting

f. Audible cues

g. Crossing islands

h. Urban furniture

i. Signage and traffic lights

j. Crosswalks

k. Sidewalks

15. Complaints in the last five years

a. Damaged infrastructures

b. Lack of sidewalk

c. Snow removal

d. Drainage

e. Lighting

f. Defective equipment

g. Obstacles

h. Abrupt slope

i. High thresholds

j. Signage

k. Work area

l. Lack of time to cross the crosswalk

Depending on the type of respondent, not all questions were presented. For example, for questions on the types of infrastructures present in the municipalities and on complaints made in the last five years, it was assumed that larger municipalities had all these infrastructures and had received complaints regarding all proposed

accessibility problems. In order to reduce the length of the questionnaire, it was decided that these questions were not to be asked to municipalities of 15,000 inhabitants or more.

It is important to recognize a distinction between smaller and larger municipalities. According to the Quebec governmental policy regarding the rights of individuals with disabilities (*À part entière: pour un véritable exercice du droit à l'égalité*) (Office des personnes handicapées [OPHQ], 2009), Quebec's municipalities of 15,000 inhabitants or more are required to have an action plan for individuals with disabilities. Those action plans, elaborated by the municipalities themselves, aim to reduce barriers of social integration for individuals with disabilities in their sector of activity and employment, ensure access to documents and services, guarantee access to goods and services, and provide sensitivity to the needs of individuals with disabilities (Office des personnes handicapées [OPHQ], 2009). Any modification made or planned to the environment or to services are documented in the action plan. This information was considered when developing the survey to reflect the reality of the different municipalities, as not all municipalities are required to apply the same actions.

Recruitment

The municipalities' classification of Quebec's ministry in charge of municipal affairs and of land use (*ministère des Affaires municipales et de l'Occupation du territoire (MAMOT)*) (Folcher, 2012) was used to classify municipalities into four groups by number of inhabitants (< 2,000 inhabitants (n=729), 2,000–9,999 inhabitants (n=292), 10,000–24,999 inhabitants (n=57), ≥ 25,000 inhabitants (n=45)). A total of 200 municipalities per group received the survey, or the total number of municipalities in the group if it contained less than 200 municipalities. The expected response rate was of 40 completed surveys per group. For the groups with more than 200 municipalities, the selection of the targeted municipalities was made by subcategorizing each group: for each increment of 1,000 inhabitants for municipalities of 2,000 to 9,999 inhabitants and each increment of 100 inhabitants for the municipalities of less than 2,000 inhabitants. Within these groups, municipalities were randomly chosen proportionally to the number of municipalities per subgroup to obtain a total of approximately 200 municipalities. For example, the group of municipalities of less than 2,000 inhabitants included 729 municipalities. In the subgroup including

municipalities of 100 to 199 inhabitants, there were 25 municipalities. If translated to find the proportional number of municipalities required to obtain 200 municipalities within the 729-municipalities group: 25 / 729 x 200 = 7 municipalities. Seven municipalities were then randomly chosen among the subgroup, but the proportion of municipalities per administrative region, as described by the MAMOT's classification, was respected.

Procedure

The *Tailored Design Method* (Dillman, 2000) was used to deploy the survey. The selected municipalities were contacted through the general e-mail address of the municipality which was provided by the *MAMOT*. The first contact was made on November 10th 2014, to inform the municipalities about the goals of the upcoming survey, and then the link to complete the survey was sent on November 12th 2014. A total of three e-mail reminders were sent, approximately every two to three weeks (November 26th 2014, December 12th 2014, January 7th 2015), when municipalities had not completed the survey.

Data analysis

Descriptive statistics and recursive partitioning analyses (Strobl, Malley, & Tutz, 2009; Zhang & Singer, 1999) (SPSS 23, proc TREE) were used. Recursive partitioning is recommended for heterogeneous samples, such as small rural towns mixed with larger urban agglomerations, and is useful for analyses of nominal, ordinal and missing data. Once the most discriminative predictor was identified, the sample was split into two subsamples. Each subsample was then analyzed separately. The next discriminative predictor may not be the same for both subsamples. Consequently, the resulting tree may reveal variability between branches. (Strobl et al., 2009; Zhang & Singer, 1999) Contrary to regression, the resulting classification tree can detect conditional predictors that are effective only for a subsample. Regression is almost blind to these situations. It assumes that all predictors are more or less active by the same dynamic on every case put into the analysis.

Recursive partitioning is also recommended for detecting interaction between predictors. The tree growing algorithm was Exhaustive CHAID and no split was allowed

unless a node contained at least 30 respondents (parent node) and the following child node should include at least 10 respondents.

With the expectation to achieve at least three levels within each branch, six times the parent node criterion (6 x 30 = 180) were selected as the targeted overall sample size (Rosner, 2006). For each significant split ($p \leq .05$ after Bonferroni adjustment), a phi coefficient was calculated based on the frequency table of the child nodes. This effect size estimate indicates the level of discrimination of the split (Field, 2009). A phi coefficient of .25 was indicative of a noticeable difference between proportions. Below this value, although statistically significant, a split may be useless. A valuable effect size of the whole tree is the percentage of correct classification between the real outcome and the estimated outcome, based on the information provided by the predictors. It is to be noted that the branching does not allow determination of whether the predictors have a causal relationship on the dependent variables; it only shows the difference in dynamics that each variable can provide regarding the variable of interest. Ideally, all categories of outcome should have a high correct classification percentage. However, one category is usually better predicted than the others. This may reflect a poor potential of prediction of an observed event in comparison to a non-event. This is the case when the non-event is better predicted. Therefore, the percentage of anticipated answers determining whether the branching represents what could be anticipated according to the respondents' answers was also calculated.

Recursive partitioning analyses were performed with the entire group of respondents. Too few larger municipalities (≥15 000 municipalities, n=50) were present to allow the inclusion of this type of municipality as predictor. Recursive partitioning analyses were performed for several dependent variables including: (a) the implementation of action plans for motor, (b) visual and (c) hearing disabilities, (d) having an employee responsible for ensuring accessibility, (e) knowledge transfer activities for employees, (f) knowing about and (g) using tools to ensure accessible pedestrian infrastructures, (h) the consultation of external resources and (i) of citizens, in the implementation of accessibility practices by including all other variables in the analysis. All the variables present in the survey were analyzed, but only those with significant results are presented in this paper (for the entire set of data of descriptive statistics, including variables that were not identified as variables of interest see supplementary files provided).

Results

Municipal practices

A total of 186 municipal representatives from 184 municipalities completed the survey. The majority of respondents have a university background (n=92/182) or have a technical professional degree (n=49/182). In municipalities of <15,000 inhabitants, many have a high school diploma as their highest diploma (n=13/132). Municipalities of <15,000 inhabitants' respondents were mainly accountants (n=33/131) or urbanists (n=16/131). Municipalities of ≥15,000 inhabitants' respondents were mainly civil engineers (15/50). Many respondents were also from a leisure, community life and recreational domain (n=17/181). The job title that was the most represented was manager (n=51/183) from various domains. Here are the descriptive statistics of the sample.

1. ≥ 25,000 inhabitants
    a. Number of contacted municipalities: 45
    b. Number of municipalities in total: 45
    c. Number of completed surveys: 33
        i. Percentage of those contacted which completed the survey: 73.3%
        ii. Percentage of completed surveys on the total number of municipalities: 73.3%
2. 10,000 – 24,999 inhabitants
    a. Number of contacted municipalities: 57
    b. Number of municipalities in total: 57
    c. Number of completed surveys: 34
        i. Percentage of those contacted which completed the survey: 59.7%
        ii. Percentage of completed surveys on the total number of municipalities: 59.7%

3. 2,000 – 9,999 inhabitants
    a. Number of contacted municipalities: 204
    b. Number of municipalities in total: 292
    c. Number of completed surveys: 60
        i. Percentage of those contacted which completed the survey: 29.4%
        ii. Percentage of completed surveys on the total number of municipalities: 20.6%
4. < 2,000 inhabitants
    a. Number of contacted municipalities: 201
    b. Number of municipalities in total: 729
    c. Number of completed surveys: 59
        i. Percentage of those contacted which completed the survey: 29.4%
        ii. Percentage of completed surveys on the total number of municipalities: 8.1%

In the following subsections we present and interpret the results regarding municipal practices. These results represent the variables of interest presented above as the content of the survey, which we will present as outcomes in the following text (e.g. action plans); the descriptive statistics and the associated recursive partitioning analysis for each will be presented. Table 1 shows one of the eight classification trees drawn from the recursive partitioning analysis. It can be used as a reference for schematizing the organization of the tree translated in a condensed format in table 2 presenting the results of all eight classification trees for each dependent variable listed above. The table identifies predictors at levels one, two and three (second, third and fourth columns of the table) of the tree. Empty cells mean that no further splits were statistically significant. The first column presents the outcomes, meaning the variables of interest in the content of the survey. The number associated to each section of the results and discussion section regarding this outcome is indicated. On the rightmost part of the table 2, the classification tables indicate how the real

situation can be predicted by the predictor variables, it's the classification table for the entire tree, it's ultimate validity test. Elements in grey are predictors that are present for more than one outcome, such that each shade represents one predictor. Phi coefficients presented in bold are significant. Note that in table 2, acronyms have been used to provide a simpler presentation of the information. Here are the correspondences for these acronyms: IHD = Individuals with hearing disabilities, IMD = Individuals with motor disabilities, IPD = Individuals with physical disabilities, IVD = Individuals with visual disabilities. Other information gathered with the survey, other than what is related to the variables of interest which provided significant results for recursive partitioning analyses can be found in the supplementary file provided.

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Table 1. Example of recursive partitioning: Responsible for ensuring accessibility (see table 2)

Outcome		**Level 1- Predictor**		**Level 2 – Predictor No branch**		**Level 2 – Predictor Yes branch**	
Variable	Responsible for ensuring accessibility	Action plan for motor disabilities		Knowing the UMQ's recommendations		Consulting individuals with motor disabilities	
Branch		**No**	**Yes**	**No**	**Yes**	**No**	**Yes**
No	59/153 (38.6%)	53/109 (48.6%)	6/44 (13.6%)	52/98 (53.1%)	1/11 (9.1%)	6/23 (26.1%)	0/21 (0.0%)
Yes	94/153 (61.4%)	56/109 (51.4%)	38/44 (86.4%)	46/98 (46.9%)	10/11 (90.9%)	17/23 (73.9%)	21/21 (100%)
p		0.000		0.023		0.047	
Chi^2		16.196		7.654		6.343	
phi		0.325		0.265		0.380	

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Table 2. Recursive partitioning results for the variables of interest in the survey

Outcome	Level 1- Predictor	Level 2 - Predictor		Level 3 - Predictor		Classification			
Implementing an action plan	For IMD	Consult IVD	IF YES		IF YES		Observed	Anticipated		
					Phi			No	Yes	Correct %
		0.439 (p=0.000)	Phi		IF NO					
					Phi					
			IF NO	Know the *Guide pratique d'accessibilité universelle* of *Quebec City*	IF YES		No	123	8	93.9
					Phi		Yes	29	26	47.3
			Phi	**0.274 (p=0.002)**	IF NO	Know the Ministry of Transportation's norms	Global %	81.7	18.3	80.1
					Phi	0.212 (p=0.036)				
	For IVD	Consult orientation and mobility specialists	IF YES		IF YES		Observed	Anticipated		
					Phi			No	Yes	Correct %
		0.564 (p=0.000)	Phi		IF NO					
					Phi		No	151	7	95.6
			IF NO	Consult IVD	IF YES					
					Phi		Yes	9	19	67.9
			Phi	**0.462 (p=0.000)**	IF NO	Civil engineering technician on the team	Global %	86.0	14.0	91.4
					Phi	**0.375 (p=0.000)**				
	For IHD	Consult IHD	IF YES		IF YES		Observed	Anticipated		
					Phi					
		0.518 (p=0.000)	Phi		IF NO			No	Yes	Correct %
					Phi		No	164	3	98.2
			IF NO	Know the *Guide pratique d'accessibilité universelle of Quebec City*	IF YES		Yes	11	8	42.1
					Phi					
			Phi	**0.401 (p=0.000)**	IF NO	Know the *INLB* and *Société Logique*'s recommendations	Global %	94.1	5.9	92.5
					Phi	**0.518 (p=0.000)**				

Outcome	Level 1- Predictor	Level 2 - Predictor		Level 3 - Predictor		Classification			
Have a responsible for ensuring accessibility	Action plan for IMD	IF YES	Consult IMD	IF YES		Observed	Anticipated		
				Phi					
	0.325 (p=0.000)	Phi	**0.380 (p=0.047)**	IF NO			No	Yes	Correct %
				Phi					
		IF NO	Know the *Union des municipalités du Québec*'s guidelines	IF Yes		No	45	14	76.3
				Phi		Yes	1	93	98.9
		Phi	**0.265 (p=0.023)**	IF NO		Global %	30.1	69.9	90.2
				Phi					
Have knowledge transfer activities regarding accessibility	Civil engineering technician on the team	IF YES	Site supervisor on the team	IF YES		Observed	Anticipated		
				Phi			No	Yes	Correct %
	0.471 (p=0.000)	Phi	**0.436 (p=0.010)**	IF NO		No	121	3	97.6
				Phi					
		IF NO	Project manager on the team	IF YES		Yes	15	10	40.0
				Phi					
		Phi	**0.363 (p=0.001)**	IF NO		Global %	91.3	8.7	87.9
				Phi					
Know tools regarding accessibility of pedestrian infrastructures	Action plan for accessibility in general	IF YES	No complaints about damaged pedestrian infrastructures (last 5 years)	IF YES		Observed	Anticipated		
				Phi			No	Yes	Correct %
	0.378 (p=0.000)	Phi	**-0.319 (p=0.006)**	IF NO	Part of *Ville amie des enfants*	No	70	24	74.5
				Phi	**0.387 (0.004)**				
		IF NO	Urbanist on the team	IF YES	Have an action plan IHD				
				Phi	**0.303 (p=0.040)**	Yes	23	58	71.6
		Phi	**0.366 (p=0.002)**	IF NO		Global %	53.1	46.9	73.1
				Phi					
Consult external resources regarding accessibility of pedestrian infrastructures for IPD	Action plan for IVD	IF YES		IF YES		Observed	Anticipated		
				Phi					
	0.482 (p=0.000)	Phi		IF NO			No	Yes	Correct %
				Phi					
		IF NO	Use of tools others than those proposed	IF YES		No	104	9	92.0
				Phi		Yes	21	35	62.5
		Phi	**0.230 (0.024)**	IF NO		Global %	74.0	26.0	82.2
				Phi					

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<table>
<tr><th>Outcome</th><th>Level 1- Predictor</th><th colspan="2">Level 2 - Predictor</th><th colspan="2">Level 3 - Predictor</th><th colspan="5">Classification</th></tr>
<tr><td rowspan="8">Consult citizens</td><td rowspan="2">Action plan for IVD</td><td rowspan="2">IF YES</td><td rowspan="2"></td><td>IF YES</td><td></td><td rowspan="2">Observed</td><td colspan="4">Anticipated</td></tr>
<tr><td>Phi</td><td></td><td></td><td>N</td><td>S</td><td>A</td><td>Correct %</td></tr>
<tr><td rowspan="2">0.372 (p=0.000)</td><td rowspan="2">Phi</td><td rowspan="2"></td><td>IF NO</td><td></td><td>No</td><td>104</td><td>7</td><td>0</td><td>93.7</td></tr>
<tr><td>Phi</td><td></td><td>Sometimes</td><td>35</td><td>19</td><td>0</td><td>35.2</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">IF NO</td><td rowspan="2">Know the INLB and Société Logique's recommendations</td><td rowspan="2">IF YES</td><td rowspan="2"></td><td>Always</td><td>5</td><td>0</td><td>0</td><td>0.0</td></tr>
<tr><td rowspan="2">Global %</td><td rowspan="2">84.7</td><td rowspan="2">15.3</td><td rowspan="2">0</td><td rowspan="2">72.4</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">Phi</td><td rowspan="2">0.150 (p=0.000)</td><td>IF NO</td><td>Manager on the team</td></tr>
<tr><td>Phi</td><td>0.096 (p=0.008)</td></tr>
</table>

****Abbreviations: IHD: Individuals with hearing disabilities, IMD: Individuals with motor disabilities, IPD: Individuals with physical disabilities, IVD: Individuals with visual disabilities*

Action plans

A total of 102 respondents (54.8%) indicated that their municipality did not have an action plan for individuals with disabilities and 16 did not know (8.6%). This mainly applies to small municipalities (<15,000 inhabitants) (NO=95/102, DON'T KNOW=14/16), which are not required to have an action plan by law. Of those who mentioned having an action plan, 13 (7.0%) did not know about its content, 55 (29.6%) had one for individuals with motor disabilities (IMD), 28 (15.1%) had one for individuals with visual disabilities (IVD), and 19 (10.2%) had one for individuals with hearing disabilities (IHD). Therefore, it seems that very few municipalities have taken action to inform their decisions to ensure access to citizens with physical disabilities, especially smaller municipalities (<15,000 inhabitants).

Action plans for individuals with motor disabilities. The most discriminative predictor presented in the recursive partitioning for the **implementation of an action plan for IMD** was the consultation of IVD to ensure accessibility of pedestrian infrastructures. This suggests that, if a municipality consults IVD, it is most likely to have an action plan for IMD. Considering IVD goes beyond the usual consideration of IMD in terms of accessibility, and considering other disabilities may lead to more inclusive practices, it is logical to presume that municipalities consulting IVD also have an action plan for IMD that may correspond to more considerations for individuals with disabilities in general. Otherwise, knowledge of the *Guide pratique d'accessibilité universelle* of *Quebec City* *(Service de l'aménagement du territoire de la Ville de Québec, 2010)*, and the characteristics public infrastructures should have, should be used to implement an accessibility action plan for IMD. In the absence of consultation of IVD and, knowledge of Quebec's Ministry of Transportation's norms (Transports Québec, 2007) favored implementation of such an action plan. The first and second nodes (i.e., consultation of IVD (0.439) and knowledge of the *Guide pratique d'accessibilité universelle* of *Quebec City* (0.274)) had a significant phi coefficient (in bold on table 2), thus are the only two variables that may influence the implementation of an action plan for IMD. The correct percentage for the anticipation of the answer 'NO, do not have an action plan for IMD' was high (93.9%), but low for 'YES' (47.3%). The resultant tree, therefore, may

predict the municipalities who do not have an action plan. The small number of municipalities that had an action plan (n=55) might influence the small percentage for the anticipation of the answer 'YES'. Since the group is smaller, it is harder to predict whether a positive answer is truly positive or if it is positive by chance.

Action plans for individuals with visual disabilities. The most important discriminative predictor for the **implementation of an action plan for IVD** was the consultation of orientation and mobility specialists to ensure accessibility. Mobility specialists have an expertise related to visual disabilities, and their input assisted with consideration for IVD. Otherwise, consulting IVD also favored the implementation of an action plan for such individuals. In the absence of these conditions, having a civil engineering technician also favored the implementation of such an action plan. This type of resource is found less frequently in smaller municipalities, where there are fewer employees and less presence of action plans for IVD. This might be the reason why the presence of a civil engineering technician seems to be related to the implementation of an action plan for IVD. Phi coefficients for each node were significant (0.375-0.564) and may predict the presence of an action plan for IVD. The correct percentage for the anticipation of the answer 'NO, do not have an action plan for IVD' was high (95.6%) and lower, but in the majority, for 'YES' (67.9%). However, these indicators seem to show that the tree adequately classifies the factors influencing the implementation of an action plan for IVD, even if the number of municipalities which answered YES was smaller (n=28).

Action plans for individuals with hearing disabilities. The most important discriminative predictor for the **implementation of an action plan IHD** was the consultation of IHD. Otherwise, knowing about the *Guide pratique d'accessibilité universelle* of *Quebec City (Service de l'aménagement du territoire de la Ville de Québec, 2010)* favored the implementation of an action plan for IHD, similar to the results for predicting action plans for IMD. In the absence of these two conditions, knowing the recommendations from *INLB and Société Logique* (Institut Nazareth et Louis-Braille & Société Logique, 2012) for IVD favored the implementation of an action plan for IHD. Although these variables might seem unrelated, similar to how knowledge of IVD influenced actions plans for IMD,

knowledge of the necessary tools for accessibility for IVD may also provide more insight into accessibility issues for IHD. Therefore, knowledge of IVD tools implies that the municipality might be more sensitive to accessibility for individuals with sensory disabilities. Phi coefficients for each node were significant (0.401-0.518) and may therefore influence the implementation of an action plan for IHD. The correct percentage for the anticipation of the answer 'NO, do not have an action plan for IHD' was high (98.2%), and low for 'YES' (42.1%). As previously explained for the implementation of an action plan for IMD, the answer NO might be well estimated because the group was larger (n=167), but too few respondents answered YES (n=19) to predict whether a positive answer is truly positive or if it is positive by chance.

Responsible for ensuring accessibility

Most respondents mentioned not having or not knowing who is responsible for ensuring accessibility in their municipality (n=59, 33 missing data). Many smaller municipalities (<15,000 inhabitants) did not have such resources (n=55, 21 missing data). Of those who mentioned having a person responsible for ensuring accessibility in their municipality, most said the person did not have a full-time job (n=4/103).

The most important discriminative predictor for **having a person responsible for ensuring accessibility in the municipality** was having an action plan for IMD. This might be due to the fact that a more structured accessibility measure, such as an action plan, might imply that someone needs to be in charge of its development, implementation and follow up. Moreover, if IMD were consulted to ensure accessibility, the likelihood of the municipality having a person responsible for accessibility was higher. Consultation of citizens needs to be planned, which is a job that may be done by the person responsible for accessibility. Otherwise, knowing about the Union of Quebec's municipalities' (*Union des municipalités du Québec*) guidelines (Union des municipalités du Québec & Culture Communications et Condition féminine Québec, 2009) also predicted having someone responsible for accessibility in the absence of an action plan for IMD. Phi coefficients for each node were significant (0.265-0.380), and these variables might influence the presence of

a responsible for accessibility. The correct percentage for the anticipation of the answer 'NO, do not have a person responsible for ensuring accessibility in the municipality' (76.3%) and 'YES' (98.9%) were high, indicating the capacity of the tree to efficiently predict whether there is someone responsible or not.

Knowledge transfer activities regarding accessibility

Few respondents mentioned that their municipality offers knowledge transfer activities regarding accessibility for IPD (n=25/149). Of those who stated that their municipality does, many did half a day theoretical training (n=15) or sensitization activities (n=10).

The most important discriminative predictor to **having knowledge transfer activities regarding accessibility** was having a civil engineering technician on the team. Moreover, if there were site supervisors on the team, the likelihood of the municipality having knowledge transfer activities regarding accessibility was higher. Otherwise, having project managers on the team predicted having such activities in the absence of a civil engineering technician. Having all these specialized resources, most often found in larger municipalities where there were more knowledge transfer activities, is then logical. Phi coefficients for each node were significant (0.353-0.471), meaning that the variables in the tree were most likely to truly influence the presence of knowledge transfer activities. The correct percentage for the anticipation of the answer (NO, do not have knowledge transfer activities regarding accessibility' (97.6%) was high and low for 'YES' (40.0%). As mentioned previously, the low count of YES answers (n=25) might not allow the discrimination between a true YES and the fact that it can be rated as YES by chance, explaining the low anticipation percentage for this answer.

Tools to create accessible pedestrian infrastructures for IPD

Some respondents mentioned knowing tools to help design accessible pedestrian infrastructures for IPD (n=81/175). However, smaller municipalities (<15,000 inhabitants) knew less about such tools (43/129).

The most important discriminative predictor to **knowing tools regarding accessibility of pedestrian infrastructures** was not having an action plan regarding accessibility in general. Without an action plan, it is likely that some municipalities employed other tools to structure their practices. Moreover, if there were urbanists on the team (mostly present in larger municipalities where tools and action plan for IHD have more chances of being known) there were even more chances for the respondent to know such tools. Otherwise, when there was an action plan, having had no complaints about damaged pedestrian infrastructures in the last five years (probably indicating that accessibility measures proposed in these tools are used), and being part of the association *Ville amie des enfants* (association for access of the municipalities for kids, being a measure grouping municipalities around various access issues which are discussed in various tools), also favored the knowledge of tools regarding accessibility of pedestrian infrastructures. Phi coefficients for each node were significant (0.303-0.387), showing the true influence of the presented variables on the knowledge of tools regarding accessibility. The correct percentage for the anticipation of the answer 'NO, do not know tools regarding accessibility of pedestrian infrastructures' (74.5%) and 'YES' (71.6%) were moderate, still indicating that the tree predicts the answer related to the variable of interest well.

Consultation of external resources regarding accessibility of pedestrian infrastructures for IPD

Few respondents consult external resources for recommendations (n=56/169). The most solicited professionals were orientation and mobility specialists (n=14), engineers (n=13) and representatives of disability groups (n=13). For those who had consulted external resources, when asked to evaluate the usefulness of these consultations, most mentioned that they were useful (n=22/54) or very useful (n=23/54).

The most important discriminative predictor for municipalities to **consult external resources** was that the municipality had an action plan for IVD, a more advanced measure of accessibility most likely to be present when other accessibility measures were present. Otherwise, the use of tools others than those proposed in the survey (not from Canada), which is a more advanced strategy to ensure accessibility, also favored the presence of this variable (consultation of external resources). Only the Phi coefficient of the second node (0.230) was not significant, indicating that the implementation of an action plan for IVD might be the only influential factor in the consultation of external resources by the municipality. Regarding the consultation of external resources, the correct percentage for the anticipation of the answer 'NO, do not consult external resources' (92.0%) was high and lower for 'YES' (62.5%), but the tree seemed to efficiently predict whether the municipality consults external resources or not.

Consultation of citizens

Most respondents mentioned that they have never consulted citizens when designing or redoing pedestrian infrastructures (n=111). Smaller municipalities (<15,000 inhabitants) consulted citizens more rarely (94/126 never do, the rest sometimes does). However, some always did (n=5) and a large proportion sometimes did (n=54) (n=170 answered the questions). For those who mentioned consulting citizens, most consulted IMD (n=33), and some consulted IVD (n=21) and IHD (n=17).

The most important discriminative predictor for **consulting citizens** was having an action plan for IVD. The fact that implementing an action plan for IVD is an advanced measure of accessibility, it is most likely to be associated to other accessibility measures. Otherwise, knowing the recommendations from *INLB and Société Logique* (Institut Nazareth et Louis-Braille & Société Logique, 2012) for IVD favored the consultation of citizens, and again considering IVD is associated with a more advanced consideration of accessibility and is more likely to be association with the presence of a greater number of accessibility measures. Even if these two conditions were not met, having managers on the team favored the consultation of citizens, which is logical since the managers can take action after the consultation

of citizens to orient practices. Only the Phi coefficient from the first node was significant (0.372), while others were low (node 2=0.150, node 3=0.096), indicating that implementing an action plan for IVD was influential. The correct percentage for the anticipation of the answer 'NO, do not consult citizens' (93.7%) was high and low for 'YES' (35.2%). Here again the answer YES was rarely used (n=59) and it is difficult to determine if this choice of answer was true or due to chance.

Need for information regarding accessibility of pedestrian infrastructures

When asked about the importance of accessibility for a list of pedestrian infrastructures (see table 3), most respondents rated each structure as important to very important. An exception to this rule was tactile tiles, for which smaller municipalities did not give much importance as compared to larger municipalities. Such a pedestrian infrastructure is considered more specialized and focuses on access for IVD. They might, therefore, not be the main concern of smaller municipalities. Another exception was refuge islands. Both smaller and larger municipalities provided answers across the whole spectrum, with a tendency of being rated as less important as the other proposed pedestrian infrastructures. This might be due to the fact that very few could or were being installed in most municipalities. The smaller municipalities (<15,000 inhabitants) tended to rate some infrastructures as less important when compared to bigger municipalities. This might be due to the fact that in some smaller municipalities, such pedestrian infrastructures were not implemented. Some municipalities also provided other answers:

- None of the infrastructures is a preoccupation (n=2, ≤2,000 inhabitants);
- Hard to answer, all pedestrian infrastructures are not present (n=3, ≤2,000 and 10,000-14,000 inhabitants);
- Color contrast for surface finishes (n=1, 15,000-24,999 inhabitants);
- Important where there is a need (n=1, ≤2,000 inhabitants);

- Models of maintenance of accessibility for detours and other paths in work areas (n=1, ≥100,000 inhabitants);
- Cycling paths and shared spaces (n=1, 25,000-99,999 inhabitants).

Table 3. Level of importance of various pedestrian infrastructures according to the respondents (<15,000 inhabitants (n=136): left column and ≥15,000 inhabitants (n=50) : right column)

Infrastructure	Level of importance (frequency)													
	Not important		A little important		Moderately important		Important		Very important		I don't know		Missing data	
Crosswalk	4	0	5	0	11	0	38	9	51	32	12	0	15	9
Curb cut	5	0	2	0	9	0	42	2	50	39	13	0	15	9
Drainage grate	3	1	4	3	16	1	48	20	36	13	14	3	15	9
Furniture	0	0	5	2	23	12	55	12	29	14	10	1	14	9
Lighting	0	1	0	1	14	3	51	13	47	23	7	0	17	9
Pedestrian lights	19	1	13	1	8	1	30	15	32	23	18	0	16	9
Refuge island	26	1	21	0	25	12	21	11	6	14	20	3	17	9
Sidewalk	4	0	3	0	12	2	40	18	49	21	13	0	15	9
Surfacing	8	1	7	1	20	11	59	19	14	7	13	2	15	9
Tactile tile	24	3	27	6	16	8	19	8	8	10	27	6	15	9

Legend: Light colored cells represent answers with a higher response rate for smaller municipalities (<15,000 inhabitants) and dark colored cells represent those for larger municipalities (≥15,000 inhabitants).

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Here is a summary of the different practices that should be favored for the outcome practices presented above to be implemented. These should be favored to improve accessibility practices in general for the design of pedestrian infrastructures.

1. Implementation of an action plan for individuals with motor disabilities (IMD)
    a. Consultation of individuals with visual disabilities (IVD)
    b. Knowing the Guide pratique d'accessibilité universelle Quebec City
    c. Knowing Quebec's ministry of Transportation's norms
2. Implementation of an action plan for individuals with visual disabilities (IVD)
    a. Consulting orientation and mobility specialists
    b. Consulting individuals with visual disabilities (IVD)
    c. Having a civil engineering technician on the team
3. Implementation of an action plan for individuals with hearing disabilities (IHD)
    a. Consulting individuals with hearing disabilities (IHD)
    b. Knowing the Guide pratique d'accessibilité universelle of Quebec City
    c. Knowing INLB and Société Logique's recommendations
4. Having a responsible for ensuring accessibility
    a. Action plan for individuals with motor disabilities (IMD)
    b. Consulting individuals with motor disabilities (IMD)
    c. Knowing the Union des municipalités du Québec's guidelines
5. Having knowledge transfer activities regarding accessibility
    a. Having a civil engineering technician on the team
    b. Having a site supervisor on the team

c. Having a project manager on the team

6. Knowing tools regarding accessibility of pedestrian infrastructures
    a. Having an action plan regarding accessibility in general
    b. Having had no complaints about damaged pedestrian infrastructures in the last five years
    c. Being part of the association Ville amie des enfants
    d. Having an urbanist on the team
    e. Having an action plan individuals with hearing disabilities (IHD)
7. Consulting external resources regarding accessibility of pedestrian infrastructures for individuals with physical disabilities (IPD)
    a. Having an action plan for individuals with visual disabilities (IVD)
    b. Use of tools others than those proposed in the survey
8. Consulting citizens
    a. Having an action plan for individuals with visual disabilities (IVD)
    b. Knowing INLB and Société Logique's recommendations
    c. Having a manager on the team

Limits

The sample was only representative of the practices in Quebec's municipalities. The generalizability of the results should, therefore, be explored in other geographic contexts. Individuals who completed the survey were not necessarily representative of all employees within their municipality, and answers remain personal rather than a consultation of all employees in the municipality. However, consultation with colleagues was suggested. Such a study could be replicated within other contexts to explore practices in other settings.

Conclusions

The objectives of this study were to describe existing supporting practices for the design of accessible pedestrian infrastructures for IPD in Quebec's municipalities (Canada) as well as to identify the perceived informational needs of the municipalities to design accessible infrastructures. As previously mentioned, the built environment is a critical component in the interaction for social participation (Patrick Fougeyrollas, 2010), and standards and practices in place should be described to determine if IPD are considered to provide them with equal changes of accessing environments. This study has shown that few municipalities have measures in place to ensure access to their pedestrian infrastructures for IPD, especially smaller municipalities of less than 15,000 inhabitants who are not required by law to have an action plan regarding accessibility. However, certain factors have proven to be closely related to the presence of many positive accessibility measures, such as the consultation of and an action plan for IVD. These are more advanced considerations of access that go beyond the usual consideration of IMD, which also allow for the consideration of a greater number of users. Moreover, having access to a greater number of varied resources and tools favors the implementation of a greater number of accessibility measures. As for the need for information regarding accessibility of pedestrian infrastructures, most municipalities mentioned the importance of accessibility of most pedestrian infrastructures proposed in the survey (crosswalk, curb cut, drainage grate, furniture, lighting, pedestrian lights, sidewalk, surfacing). In order to ensure access to such infrastructures, it is critical to provide municipalities with the information that is required for ensuring an adequate design process. Adequate design measures for accessible pedestrian infrastructures for IPD should not only be recommended, but should be part of construction norms and legislations for equity of access and social inclusion. These findings provide greater knowledge on what to target in order to improve access in municipalities and provide suggestions for replication in other geographic regions. However, external factors might also influence the applicability of certain accessibility practices, such as the receptivity, implication and sensitivity of stakeholders in decisions regarding IPD and their expertise in the

field, and have not been treated in the present study but are of great importance in ensuring the consideration of all citizens, regardless of their capabilities.

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