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Review of planning, land use, and zoning barriers to the construction of Transit-oriented developments in the United States

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ABSTRACT

Through a literature review and national surveys of transit agencies and local governments in the United States, this study contributes to the planning and policy research by identifying the major planning, land use, and zoning barriers to the construction of transit-oriented developments (TODs) in the US. It also discusses strategies suggested by the literature, the local governments, and the transit agencies to address these barriers. Select strategies include: provide flexible parking standards and uses in the TODs; shift the focus from ground-floor retail in a TOD to the broader objective, an active ground floor; and consider TOD a transit infrastructure for land acquisition purposes.

1. Introduction

Transit-oriented development (TOD) refers to a moderate to high-density urban development that ranges in scale from a single building to a neighborhood. It is usually located within one-half mile of a transit station to which it has direct connectivity. A TOD promotes walkability, bikeability, and access to transit; and discourages the use of private automobiles (Belzer and Autler, 2002; Bernick and Cervero, 1997; Boarnet and Compin, 1999; Cervero, 2007; Cervero et al., 2002; Cervero et al., 2004; Curtis et al., 2009; Dittmar and Ohland, 2004; United States Environmental Protection Agency (EPA), 2013; Krizek, 2003; Lierop et al., 2017; Porter, 1997; Thrun, Leider and Chriqui, 2016).

The interest in TODs has heightened in the US in the last 3–4 decades due to an increased awareness of the negative impacts of sprawl on inner cities, the environment, public health, municipal budgets, the vitality of urban spaces, and housing and transportation choices (Burchell et al., 2002; Frank et al., 2006; Frumkin et al., 2004; Levine, 2006; McDonald et al., 2010; Newman and Kenworthy, 1999). Furthermore, many population sub-groups such as low-income households, children, and the elderly often bear disproportionate impacts of sprawl (Frumkin, 2002; Helling, 2002; Sturm and Cohen, 2004). This awareness has encouraged governments at all levels—from federal to local—to implement various policies and implementation tools to combat sprawl. These tools fall

under the umbrella of growth management (GM)/smart growth (SM). Many of them focus on decreasing the rate of expansion of urban areas, rejuvenating inner cities, promoting compact and equitable urban development, and integrating transportation with land use (Addison et al., 2013; Ewing and Cervero, 2010; Landis, 2019; Rast, 2006).

Moreover, workers of the high-tech and talent economies are demanding vibrant, walkable, bikeable, mixed-use urban spaces (Arrington et al., 2008). Finally, literature has linked various dimensions (Ds) of the built environment (and its occupants) to transportation mode choice and transit ridership. These Ds include density, diversity (mix of land uses), design (connectivity of street network), destination accessibility, distance to transit, demand management, demographics, and development scale (Cervero and Kockleman, 1997; Cervero and Gorman, 1995; Ewing et al., 2011; Ewing and Cervero, 2010; Ewing and Cervero, 2001; Handy, 1993).

TOD is a smart growth tool that serves all these purposes; namely, increases transit ridership; reduces vehicles miles traveled, vehicular emissions, and traffic congestion; provides transportation choices and affordable housing; enables compact and mixed-use developments; creates vibrant urban spaces; and promotes walkability, bikeability, and sustainable development (ARB, 2017; ARB, 2016; Arfeh and Zhang, 2014; Bedsworth, Hanak, and Kolko, 2011; Belzer and Autler, 2002; Caltrans, 2002; Cervero, Ferrell and Murphy, 2002; Cervero and

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Kockelman, 1997; Chatman, 2013; Dunphy et al., 2003; Knowles, Febrache and Nikitas, 2020; Lund, 2006; Metropolitan Transportation Commission (MTC), 2005; Regional Transportation Authority (RTA), 2012; Renne, 2005; Renne et al., 2011; Thomas and Bertolini, 2017; Thomas et al., 2018). Furthermore, the interest in providing affordable housing in TODs has spawned the relatively recent advocacy, research, and policy work on equitable TODs, or eTODs. This body of work views TODs as tools to link smart growth, environmental justice, and equity (for example, see Appleyard, Frost and Allen, 2019; Chava, Newman and Tiwari, 2019; United States Environmental Protection Agency (EPA), 2013).

While TODs remain a desirable goal, several, often interconnected, barriers hinder their construction in the US. These include political; economic; financial; institutional; regulatory; quality of transit system; policy; and planning, land use, and zoning (PLUZ) barriers (Arrington et al., 2008; Belzer and Autler, 2002; Caltrans, 2002; Cervero, Ferrell and Murphy, 2002; Cervero et al., 2004; Dumbaugh, 2004; Hess and Lombardi, 2004; Knowles, Febrache and Nikitas, 2020; Porter, 1997; Renne et al., 2011; Regional Transportation Authority (RTA), 2012; Thomas et al., 2018). The PLUZ barriers include an absence of supportive planning, land use, and zoning in and around transit stations, limitations on the density and diversity of uses in TODs. Among others, they lead to poor TOD-transit station connectivity. Furthermore, the land use and zoning efforts are often not embedded into the city- or metropolitan-area-wide transportation and land use planning efforts, resulting in the piecemeal implementation of TOD (Cervero et al., 2002).

The US-focused extant literature has surveyed the PLUZ barriers to TODs and ways to remove them. However, the literature needs an update, with the last comprehensive review undertaken around 15 years ago (see Porter, 1997; Cervero, Ferrell, and Murphy, 2002; Cervero et al., 2004). Moreover, it primarily focuses on one type of TOD, for example, Hess and Lombardi's (2004) literature review of inner-city TODs.¹ Furthermore, we know little about the current views of the two agencies at the front line of implementing TODs in the US—local governments and transit agencies—on PLUZ barriers and the steps these agencies take to address them. This paper begins to fill these research and practice gaps.

1.1. Research questions

This study answers the following research questions:

- a) What are the major PLUZ barriers to the construction of TODs in the US; and
- b) What strategies are suggested by the literature, the local governments, and the transit agencies to address these barriers?

1.2. Methodology

First, we reviewed academic and professional literature to identify the various types of PLUZ barriers to TODs in the US and the strategies that could be employed to address these barriers. Next, we conducted two national surveys—one of the transit agencies and the other of the local/city governments. We used the Federal Transit Administration's (FTA) National Transit Database (NTD) to identify the top-101 transit agencies in the US based on unlinked passenger trips (transit industry's

¹ We discuss these and other relevant pieces of literature in the Literature Review section of the paper.

standard measure for ridership)², and the US Census data to identify the largest city by population in each of these transit agencies' service area. The surveys complement the literature review and expand existing research by identifying the views of the public agencies' staff about the PLUZ barriers faced while implementing TODs and how they can overcome these barriers. Finally, we synthesized information obtained from the two sources—literature and surveys—to identify the major findings concerning the PLUZ barriers faced and discuss strategies suggested by the literature, the local governments, and the transit agencies to overcome them.

1.3. Paper organization

We have organized the rest of the paper as follows: the following two sections glean insights from the literature and the surveys to describe the PLUZ barriers to the construction of TODs in the US and the strategies employed to overcome them. The subsequent section synthesizes these insights and provides a set of recommendations. The final section concludes the paper by summarizing the key findings and highlighting future research opportunities.

2. Literature review

This section briefly reviews all the major non-PLUZ barriers and concludes with an in-depth discussion of the PLUZ barriers and strategies to address them.

² We conducted the surveys in 2019 and took the following steps to identify the top transit agencies. First, we downloaded Annual Data Tables for 2017 from the Federal Transit Administration's National Transit Database website as an EXCEL spreadsheet that contained four worksheets. The worksheet titled "Metrics" contained details for 3,711 transit agencies. Second, we omitted the agencies identified as "Rural Reporter," "Reduced Reporter," "Tribe," "University," and "Private-for-Profit." Third, under the column titled "State" we selected the 50 US states. This selection led to the omission of one transit agency in Puerto Rico (a US territory). Fourth, we deleted duplicate transit agencies' names. Five hundred and twenty-four transit agencies remained in the dataset after this step. Fifth, we calculated the average and median for the unlinked passenger trips for the dataset. The average is around 18 million, and the median, approximately 1.6 million. The wide difference between the average and the median (with the average much higher than the median) indicates that few transit agencies have a very large number of unlinked passenger trips. Sixth, we organized the data by the decreasing number of unlinked passenger trips to investigate data distribution. Fourteen transit agencies had more than 100 million unlinked passenger trips. We calculated the average and median for unlinked passenger trips after excluding these 14 large transit agencies. The average is approximately 6 million, and the median, 1.5 million. Finally, we used a threshold of 6 million unlinked transit trips to select transit agencies for the survey. This threshold resulted in a list of 107 transit agencies. In many cases, city/county departments run the transit systems. We sent either the transit survey or the local government survey to the appropriate city/county government in such cases. We conducted online searches to identify the appropriate personnel to send the survey; an ideal respondent being the person managing the planning and implementation of TODs for a transit agency. We used a combination of keywords such as "[name of the transit agency]," "property division," "real estate," "TOD," "TOD manager," "transportation planner," "executive staff," and "executive team," to identify the appropriate staff. Finally, we conducted searches to find their email addresses. In six cases, we could not find the email addresses, or the email bounced back. So, in all, we sent out 101 transit surveys. To choose the local governments to send the surveys, we first identified the largest city by population served by each of the above-selected 107 transit agencies, assuming that big cities are more likely to support TODs than smaller cities. Finally, we sent 82 local government surveys because, in many cases, more than one transit agency served the city, had already sent the transit survey, or could not find the email addresses.

2.1. Major categories of barriers

Extant literature has primarily grouped barriers to TOD in six, often interrelated, major categories—economic and financial/fiscal barriers, organizational/institutional barriers, political barriers, policy barriers, regulatory barriers, and the quality of the transit system. The PLUZ barriers faced by TODs in the US are sprinkled across most of these major categories. For example, [Cervero, Ferrell and Murphy \(2002\)](#) discuss them under political barriers, [Porter \(1997\)](#) under regulatory, [Cervero et al. \(2004\)](#) discuss some PLUZ barriers (for example, fiscal or exclusionary zoning) under fiscal barriers and others (such as parking- and mixed-use-related barriers) under “barriers unique to TODs,” and [Cervero, Bernick and Gilbert \(1994\)](#) discuss some under political and the other under structural barriers. Furthermore, several studies note the primacy of local governments and transit agencies in influencing the implementation of TODs through various tools such as the use of agency-owned land, land acquisition, land use regulatory powers, comprehensive planning policies, and zoning provisions ([Cervero, Ferrell and Murphy, 2002](#); [Dumbaugh, 2004](#); [Hess and Lombardi, 2004](#); [Porter, 1997](#); [Renne et al., 2011](#)). The use of these tools highlights the need to consider PLUZ barriers as a separate category, which we have done in this paper. [Table 1](#) lists the non-PLUZ barriers discussed in the literature, and [Table 2](#), the PLUZ barriers. We discuss both these groups of barriers below.

2.1.1. Non-PLUZ barriers

Economic and Financial/Fiscal Barriers: These barriers include weak economy and real estate market (especially for TODs); lack of financing; rigid loan underwriting standards that discourage mix of uses and affordable housing and require high levels of parking; and high construction costs and risk.

Construction cost risks are especially high for TODs in the inner city or already urbanized areas of the US that often require infrastructure upgrades and environmental remediation ([Caltrans, 2002](#); [Belzer and Autler, 2002](#); [Dumbaugh, 2004](#); [Thomas et al., 2018](#)). Furthermore, these TOD projects run the risk of significant revisions or cancellations ([Guthrie and Fan, 2016](#); [Noland et al., 2017](#)). Moreover, risk and costs further increase due to an insufficient supply of vacant developable land and difficulty assembling land ([Caltrans, 2002](#); [Cervero, Bernick and Gilbert, 1994](#); [Dong, 2016](#); [Guthrie and Fan, 2016](#); [Levine and Inam, 2004](#); [Pojani and Stead, 2014](#); [Searle et al., 2014](#); [Tan et al., 2014](#); [Thomas et al., 2018](#)). Additional hurdles include large initial capital investment, an extended project gestation period, and a lack of dedicated public funds for TOD planning and construction ([Cervero and Dai, 2014](#); [Searle et al., 2014](#); [Tan et al., 2014](#)).

[Cervero et al. \(2004\)](#) and [Hess and Lombardi \(2004\)](#) note that new transit lines are often developed in areas with low land costs, weak real estate markets, and along abandoned rail lines. Furthermore, conventional lenders are unwilling to fund TODs that vertically integrate mixed uses. Finally, TODs (especially mixed-use TODs) face uncertain market demand in the US because they are a new real estate product for many localities ([Cervero et al., 2004](#)).

Organizational/Institutional Barriers: A lack of coordination and collaboration among various stakeholders such as local governments, transit agencies, and developers, is the most noted organizational/institutional barrier in the literature ([Belzer and Autler, 2002](#); [Cervero et al., 2004](#); [Cervero and Dai, 2014](#); [Knowles, Febrache and Nikitas, 2020](#); [Ibraevaa et al., 2020](#); [Pojani and Stead, 2014](#); [Staricco and Vitale Brovarone, 2018](#); [Tan et al., 2014](#)). This lack of coordination may be due to the competition between local governments for new development and funding, a lack of a regional land use-transportation planning agency, unclear terms of interactions, and a lack of a project leader ([Noland et al., 2017](#); [Searle et al., 2014](#); [Staricco and Vitale Brovarone, 2018](#); [Tan et al., 2014](#); [Thomas et al., 2018](#)). Furthermore, stakeholders may not share information on how to structure joint development agreements, reduce costs, maximize profits ([Thomas et al., 2018](#)), or the benefits and

Table 1
Non-PLUZ barriers discussed in the literature.

Barrier type	Barrier's description
Economics and Financial/ Fiscal	Weak economy and real estate market Lack of financing for TODs Rigid loan underwriting standards High level of parking High construction costs and risks
Organizational/ Institutional	Lack of coordination/collaboration among stakeholders Lack of expertise to implement TODs Transit agencies' view of themselves as transit operators, not developers Suburban cities' majority on transit agencies' boards
Political Barriers	NIMBYism: spot congestion Weak regional governance Advocacy by park-and-ride patrons for station area parking
Policy Barriers	Weak national, regional, and local support for TODs Lack of consensus regarding goals of TODs Node-place conflict Lack of state-level policy on TOD
Regulatory Barriers	States may prohibit transit agencies from pursuing real estate development Lack of enabling state-level legal environment for transit agencies to use tools such as eminent domain and joint development agreements State laws requiring sale of state-owned lands to highest bidder Statutes prohibiting TODs around transit agencies
Quality of the transit system	Low transit accessibility and mobility compared to automobiles

Table 2
PLUZ barriers discussed in the literature.

Barrier type	Barrier's description
Regional and Local Planning	Lack of integration of TODs with the comprehensive planning processes Lack of consideration of land uses around each transit station in the context of their impact on system-wide ridership Lack of sound planning that reduces uncertainties in the development process Lack of integrated transportation and land use decision-making
Zoning	Fiscal zoning: big-box retail favored over TODs; single-family over-zoned and multi-family under-zoned; a higher level of retail required than market can bear Parking-related challenges: high minimum parking in TODs; inflexible parking standards; on-site parking requirement; unbundled or shared parking prohibited; replacing parking for one mode with other modes prohibited Barriers to mixed-use TODs: zoning prohibits mix of uses; excessive ground floor retail; zoning changes to allow TODs risky and resource-intensive; need to use multiple Ds of built environment Density-related barriers: maximum density requirements; building height restrictions; setback and buffering requirements; minimum street width requirements; building height and FAR restrictions; complicated zoning and building permitting processes; environmental regulations Institutional factors: Limited or no PLUZ powers to transit agencies; local public agencies' opposition to granting PLUZ powers to transit agencies; lack of clear legal authority to transit agencies to use PLUZ powers (piecemeal legislation)
Urban Design	Need to move beyond the design-related D of the built environment that focuses on street connectivity only Poor urban design and aesthetic appeal of the TOD

effects of constructing TODs ([Caltrans, 2002](#)). Overall, the lack of coordination may lead the various actors in the TOD implementation process to be unwilling to experiment with new and innovative TOD policies, practices, and tools ([Thomas et al., 2018](#)).

Furthermore, local governments, developers, and transit agencies in

the US often lack the expertise to implement TODs, especially mixed-use TODs that involve a variety of risks, lenders, investors, and funding options (Belzer and Autler, 2002; Caltrans, 2002; Cervero et al., 2004; Cervero et al., 2002). Moreover, transit agencies may not see implementing TOD as their role because they may not view themselves as developers instead of only transit operators (Caltrans, 2002). Indeed, a US-wide survey of transit agencies revealed that only a few agencies had full-time staff devoted to TOD. Moreover, in most cases, the agencies' board members felt that constructing TODs was not a transit operators' role (White and McDaniel, 1999). However, more recent literature finds growing interest among the larger transit agencies to coordinate TOD efforts with local governments (McMahon et al., 2016) and establish capacity for land use planning, real estate development and law, and community outreach (Deakin et al., 2002).

Finally, United States Environmental Protection Agency (EPA) (2013) notes that the boards of transit agencies are often composed of one representative from each jurisdiction served—usually many smaller suburban towns and one large inner city. The population is not the criterion for representation. Hence, outlying urban areas are likely to receive the majority of transit investments at the expense of the urban core, where transit-dependent communities often live, and population densities are usually high enough to support transit.

Political Barriers: The literature notes that NIMBYism (Not-in-My-Backyard), which in this case is a local community's opposition to transit and compact development (especially multi-family housing), is a significant political barrier (Caltrans, 2002; Cervero et al., 2004; Cervero et al., 1994; Cervero et al., 2002; Ibraeva et al., 2020; Thomas et al., 2018).

Spot congestion caused by TODs, where congestion increases locally while it might reduce regionally, is often the source of NIMBYism and leads some local governments to downzone (or not up zone) station areas (Cervero et al., 2004). Other barriers include weak regional governance (Thomas et al., 2018) and advocacy by park-and-ride patrons (Cervero et al., 2002) for ample station area parking that leads to auto-oriented station areas and increases local community's concerns about traffic congestion. Finally, Thomas et al. (2018) note weak national, regional, and local political support for TOD (or frequent changes to the level of support) as a barrier internationally.

Policy Barriers: Belzer and Autler (2002) argue that a lack of consensus regarding the goals of TODs (for example, should TODs maximize ridership or maximize lease revenues? Or, should they result in vibrant urban spaces?) often results in a patchwork of policies that counter each other. In such a fragmented policy environment, the two key stakeholders—transit agencies and local governments—are often unable to develop a shared vision for TOD.

Node-place conflict discussed by Belzer and Autler (2002) and Cervero et al. (2004) is another example of policy ambiguity. A transit agency may view a station as a functional *node* that should feed riders to their transit systems as efficiently as possible. In contrast, planners might view a station as a desirable *place*. Viewing a station as a node, transit agencies might require ample parking at the stations, which could work against planners' vision of the station area as a vibrant, walkable, and bikeable place.

Finally, a lack of state-level policy on TOD is a barrier. Such a policy can help fund station-area planning and infrastructure improvements, promote coordination among state agencies, create incentives for regional planning, facilitate public-private partnerships, establish TOD pilot programs, and reduce regulatory and legislative barriers to TOD-supportive land use (Renne et al., 2011). Indeed, Cervero et al. (2002) fear that the absence of clear state-level policy might have steered some transit agencies away from implementing TODs. Finally, state-level GM policies and the regional and local vision and policies, especially for land use-transportation coordination and urban sustainability, are critical for TOD success (Porter, 1997; Thomas et al., 2018).

Regulatory Barriers: States in the US may prohibit transit agencies from pursuing real estate development activities (White and McDaniel,

1999; Cervero et al., 2002). Furthermore, state law may not provide the enabling legal framework for transit agencies to engage in activities critical to developing TODs (Deakin et al., 2002; Cervero et al., 2004), such as the use of eminent domain to acquire land for TODs or to enter into joint development agreements to construct TODs.

Some state-level regulations indirectly restrict TODs. For example, land disposition laws may require state agencies to sell land to the highest bidder, regardless of the proposed use, resulting in station-area land parcels sold to buyers who have no interest in developing TODs (Caltrans, 2002). Finally, Arrington et al. (2008) note that TODs are still not allowed around transit stations in several cities.

Quality of the Transit System Barrier: High-quality transit service that provides accessibility and mobility comparable to those offered by automobiles is vital for TODs' success (Arrington et al., 2008; Knowles et al., 2020).

2.1.2. PLUZ barriers

The literature notes the following as the major sub-categories of PLUZ barriers: the lack of regional and local planning, including physical/land use planning and transportation planning; unsupportive, inflexible, or fiscal zoning; and poor urban design of the station areas and TODs.

Regional and Local Planning Barriers: Focusing on planning at the transit-system-wide scale, Belzer and Autler (2002) emphasize the need to consider land uses around each station in the context of how they would impact system-wide ridership. Highlighting the need for regional and long-range planning, Cervero et al. (2002) note that the success of TOD implementation tools (such as local zoning) depends partially on how well these tools integrate with the comprehensive planning processes. The authors argue that TODs are likely to be developed piecemeal without comprehensive planning, perhaps as one or two exceptions in the larger auto-oriented urban form. Real estate developers also stress the need for sound planning to reduce uncertainties in the development process (Belzer and Autler, 2002). Finally, Cervero et al. (2002) note the need to integrate transportation and land use decision-making, a point reinforced in Caltrans (2002) that points to a lack of effective coordination among transit agencies and the local and regional land use and transportation planning agencies as a challenge to implementing TODs.

Zoning Barriers: Literature points to fiscal zoning; and parking-, mixed-use-, and density-related barriers. Mixed-use (diversity) was one of the original 3 Ds of the built environment deemed critical for promoting transit ridership (Cervero and Kockelman, 1997).³ However, these Ds are less effective individually, compared to if they exist in combination. For example, higher density, diverse uses, and the walkable urban form must occur in combination, with density above a minimum threshold (Arrington et al., 2008). Similarly, Renne (2005) notes that ridership benefits could be realized through a combination of high density and reduced parking in the station areas.

The literature on fiscal zoning notes that fiscalization of land use in the US may lead local governments to favor big-box retail over TODs. Furthermore, these governments may primarily zone for single-family houses, restrict multi-family housing development, and require a higher level of retail in TODs than the market can support (Caltrans, 2002; Belzer and Autler, 2002; Cervero et al., 2004; Urban Land Institute (ULI), 2003).

TODs face several parking-related challenges. The zoning and building codes often do not differentiate between conventional developments and TODs, thereby requiring very high minimum parking in TODs. The resultant oversupply of parking increases the cost of constructing TODs, hampers the creation of a walkable environment, favors sprawled automobile-oriented station-area urban form, and increases station-area traffic congestion (Arrington et al., 2008; Caltrans, 2002; Ewing et al., 2017; Guthrie and Fan, 2016; Levine and Inam, 2004;

³ Density and design are the other two 2 Ds.

Ibraevaa et al., 2020; Pollack, Bluestone and Billingham, 2010; Porter, 1997).

Furthermore, parking standards are often inflexible in the US. They do not take into account the characteristics and requirements of each station (Regional Transportation Authority (RTA), 2011). For example, terminal stations with large catchment areas may require more parking than the intermediate stations (Cervero et al., 2002). Moreover, parking standards usually require on-site parking. They do not allow unbundled or shared parking (Pollack, Bluestone and Billingham, 2010; Regional Transportation Authority (RTA), 2012), or a district-wide approach with parking spread throughout the station area (Caltrans, 2002). Furthermore, they may not allow replacing parking for one mode (for example, automobile parking) with that for others, such as bicycle parking (Pollack et al., 2010).

Arrington et al. (2008) and Clifton et al. (2015) further establish a link between parking, land use, and transportation planning by noting that Institute of Transportation Engineers (ITE) trip generation rates are likely inflated for TODs. The ITE trip generation handbook does not identify TODs as a separate land use category. This trip inflation could increase TODs' development costs, reducing their financial viability. For example, TODs might have to pay high impact fees and provide excessive parking, often leading to the construction of expensive structured parking garages (Arrington et al., 2008).

Several barriers exist to mixed-use TODs in the US. First, local zoning often prohibits a mix of uses (Porter, 1997). Second, while literature highlights the need for fine-grained mixing of uses which often requires vertical mixing (Thomas et al., 2018; Knowles et al., 2020), Caltrans (2002) and Cervero et al. (2004) note that such mixing (especially vertical mixing) could run against loan underwriting standards. Third, in their quest to create vibrant urban spaces and for fiscal reasons, local governments typically require ground-floor retail in TODs, often more than the market can support (Cervero et al., 2004; Arrington et al., 2008; Urban Land Institute (ULI), 2003). The oversupply of retail results in its high vacancy, which, in turn, reduces the urban vitality and financial viability of TODs. Furthermore, it could be risky and resource-intensive to change zoning to allow TODs (Caltrans, 2002).

The literature on the density-related barriers points that local zoning and building code requirements hamper TOD implementation. These requirements include maximum density limits, building height restrictions, setback and buffering requirements, minimum street width requirements, and building height and floor area ratio (FAR) restrictions (Porter, 1997; Cervero et al., 2002).

Complicated zoning and building permitting processes and other regulations, such as the California Environmental Quality Act (CEQA), hinder TODs too by making the permit approval process long (often several years). The lengthy permit approval process increases project risk and development cost (Schuetz et al., 2018; Glaeser, Schuetz and Ward, 2006; Olshansky, 1996), hence the call to streamline zoning (Regional Transportation Authority (RTA), 2012).

Finally, other, institutional-level factors create zoning-related barriers. For example, transit agencies in the US often have limited or no PLUZ powers over land in and around transit stations (Cervero et al., 2004; Renne et al., 2011). Furthermore, public agencies such as city governments or redevelopment agencies might oppose granting transit agencies land use or zoning powers (Cervero et al., 2004). These barriers are difficult to surmount in the absence of incentives for inter-agency coordination (Cervero et al., 2002; Dumbaugh, 2004) or clear legal authority, such as the pieces of state-level enabling legislation that grant transit agencies zoning power and authority to undertake real estate development.

Urban Design Barriers: While the earlier literature on the Ds of the built environment focused only on the connectivity of the street network under the D of design, more recent literature specifically calls out poor urban design and aesthetic appeal of TODs as barriers (Thomas et al., 2018). High-quality urban design in TOD projects helps accommodate various transportation types and mix of uses while ensuring high

aesthetic appeal (Jacobson and Forsyth, 2008). Furthermore, good-quality building and urban design increase TOD's market appeal by making high-density urban forms attractive places to live, work, and visit (Arrington et al., 2008).

2.2. Strategies to address PLUZ barriers

Below, we discuss the various strategies highlighted in the literature to address planning, land use, zoning, and design-related barriers to TODs. We have organized these strategies by the role of federal, state, regional, and local governments; and transit agencies in implementing them.

2.2.1. Federal Role:

The US federal government started advocating for TODs in the 1970s as a value capture tool to offset the cost of new transit systems (Caltrans, 2002). However, a robust federal push to promote land use-transportation coordination at the metropolitan scale and TOD-supportive planning and zoning at the local scale came in the 1990s with the Intermodal Surface Transportation Efficiency Act (ISTEA). This act identified transit-supportive land use policies as one of the project selection criteria for awarding funds under the FTA's New Starts program (Renne et al., 2011). FTA has further refined the land use criterion since then. The latest version of the criteria evaluates project applications on a) whether the population and employment densities are adequate to support the transit system, b) pedestrian-friendliness of the stations, and c) the proportion of affordable housing in the transit corridor (Federal Transit Administration (FTA), 2013).

The federal government took a more direct interest in TOD planning through a TOD-specific program funded under the next transportation act, The Moving Ahead for Progress in the 21st Century Act (MAP-21), which established FTA's Pilot Program for TOD Planning. This program was amended by the subsequent federal transportation act, Fixing America's Surface Transportation Act (FAST) of 2015, and was authorized until the financial year 2020 (Vantuono, 2018). It provides "funds to local communities to integrate land use and transportation planning with a new fixed guideway or core capacity transit capital investment." Furthermore, it requires that "comprehensive planning funded through the program must examine ways to improve economic development and ridership, foster multimodal connectivity and accessibility, improve transit access for pedestrian and bicycle traffic, engage the private sector, identify infrastructure needs, and enable mixed-use development near transit stations" (Federal Transit Administration (FTA), 2019). Finally, the federal government freed up transit-agency-owned station land for TODs by allowing land acquired for transit purposes⁴ with FTA funds for other transit-supportive purposes, such as joint development of TODs with a private developer (Federal Transit Administration (FTA), 2016).

2.2.2. States' role

States in the US could address PLUZ barriers through legislation, policies, and funding, thereby providing the legal and policy framework and support for regional and local planning and zoning initiatives. For example, state-level GM programs, such as Washington State's, have tools including concurrency and urban growth boundaries (UGBs) to direct growth. Under the concurrency requirement, the issuance of a building permit can be contingent on the provision of infrastructure (such as transportation, sewers, and water supply) concurrently with growth. Therefore, TODs can be encouraged by using concurrency to direct development toward areas with high-quality public transportation. Concurrency exemptions for TODs proposed in areas around transit could provide further incentives (White and McDaniel, 1999).

Similarly, states can require or incentivize a) consistency between

⁴ Such uses include station, rail right-of-way, and maintenance yard.

regional and local planning documents and between land use and transportation planning elements of a city's general plan, and b) improved land use and transportation coordination at regional and local levels. States can also fund station-area and TOD planning studies and model ordinances (Caltrans, 2002). Furthermore, infrastructure development or planning assistance, such as grants and loans, can be contingent upon zoning reforms or require expending funds in areas around transit stations for station-area planning and capital improvements (Cervero et al., 2004).

Finally, state-level statutes, policies, and programs can address some of the local PLUZ barriers in two significant ways: first, by directly facilitating TODs, and second, by promoting objectives co-aligned with TODs', such as compact development, housing mix, affordable housing, and pedestrian- and bike-friendly environments.

Examples of the first kind of statutes and policies include Oregon's Transportation Planning Rule that requires local governments to revise zoning ordinances to allow TODs around major stations (Renne et al., 2011). Moreover, states can formulate regulations that facilitate joint development TOD projects by providing transit agencies the power to enter into joint development agreements with private developers. Furthermore, state regulations can specify the kinds of actions permissible under such agreements, such as whether transit agencies can grant development and easement rights to private entities (White and McDaniel, 1999).

Examples of the second kind include California Density Bonus Law and its various amendments such as AB 1818 (California Legislative Information, 2004) and AB 744 (California Legislative Information, 2015). This law grants developers up to a 35% density increase in-lieu of developing affordable housing. It also allows reduced parking and smaller building setbacks (Goetz and Sakai, 2019). Specifically, AB 744 lowers parking requirements for affordable housing. The projects that provide the legislation-specified deepest level of affordability are required to provide only 0.5 parking spaces per housing unit (California Legislative Information, 2015). Therefore, the density bonus law can promote affordable housing both in TOD and non-TOD areas.

2.2.3. Role of regional agencies

The literature calls for regional agencies in the US, such as metropolitan planning organizations (MPOs) and council of governments, to enable land use-transportation coordination; develop TOD-supportive regional vision, plans, policies, guidelines, and standards; and to fund TOD planning (Caltrans, 2002; Ibraevaa et al., 2020; Porter, 1997; Thomas and Bertolini, 2017).

Cervero Ferrell and Murphy (2002) provide an example of a TOD-supportive regional plan. Sacramento, CA's Regional Transit District included TOD design standards in its transit master plan and modified street standards in its TOD policies. The Housing Incentive Pool (HIP) program and the One Bay Area Grant program of the Metropolitan Transportation Commission (MTC)—the MPO for the San Francisco Bay Area—are examples of regional-level TOD funding programs. These programs provide financial incentives to developers to construct affordable housing and local governments to undertake planning in the areas that are earmarked for future growth and have high-quality transit service (Metropolitan Transportation Commission (MTC), 2020a; Metropolitan Transportation Commission (MTC), 2020b).

Finally, the Southern Nevada Regional Planning Coalition, a group of elected officials from the local jurisdictions of Southern Nevada, Clark County, and the Clark County School District, was tasked by the state legislature to develop a regional plan for the region's sustainable development using tools such as mixed-use TODs (Renne et al., 2011; Willson, 2020).

2.2.4. Role of local governments

In the US, local governments can significantly reduce PLUZ barriers through ordinances; comprehensive, neighborhood, and station area planning processes; TOD design guidelines and policies; revisions to

zoning and building codes; financial and other incentives such as expedited permit approval for TODs; and cooperative arrangements with other local governments and transit agencies (Cervero et al., 2002; Porter, 1997).

The local ordinances and planning processes can aid TOD implementation by ensuring consistency with the regional and state-level plans, policies, and guidelines. Furthermore, they can provide the overarching TOD-supportive framework for implementing specific tools such as overlay zoning, developer agreements, specific plans, planned unit development process, financial incentives, capital improvement plans, and inclusionary, mixed-income housing; and transfer of development rights (TDR) program⁵ with TODs as receiving zones (Belzer and Autler, 2002; Thomas et al., 2018; White and McDaniel, 1999).

In California, San Jose's general plan process provides an example of consistency with the regional plan, The Plan Bay Area. The city's general plan promotes compact, mixed-use developments in the priority development areas identified in the regional plan.

Zoning and building codes can promote higher density by prescribing maximum, not minimum, lot sizes; providing density bonuses; allowing higher FARs; relaxing building height; and zoning for compact housing types such as apartments, condominiums, and townhouses (Cervero et al., 2004). In addition, these codes can promote mixed-use zoning by allowing mixing of residential, commercial, and office uses; allowing uses to change over time (flexible land use); and identifying permitted, accessory, and conditional uses (Porter, 1997; The Fourth Regional Plan. n.d.; Thomas et al., 2018).

Regulations and incentives facilitating adaptive reuse of properties that would otherwise not meet the current zoning and building codes also help (Riggs and Chamberlain, 2018). For example, inner cities' historic buildings constructed in the pre-automobile era are often vacant because they cannot meet the current parking requirements (Frey and Bowdon, 2012; Manville, 2013; Manville and Shoup, 2010) and zoning. Additionally, zoning may prohibit the reuse of historical industrial buildings for commercial or residential uses (Cantell, 2005).

Zoning and building codes can address parking-related barriers. They can do so by prescribing maximum, not minimum parking standards; relaxing parking requirements for TODs; providing flexible parking standards; restricting off-street parking; and incentivizing shared, paid, unbundled, and on-street parking. Finally, they can allow substitution of automobile parking with non-auto modes such as bikes; allow structured parking; and establish remote parking outside the station area, freeing land close to station areas for transit-supportive development (Belzer and Autler, 2002; Cervero et al., 2002; Cervero et al., 2004; Porter, 1997; United States Environmental Protection Agency (EPA), 2013; Jacobson and Forsyth, 2008; Pollack, Bluestone and Billingham, 2010; Regional Transportation Authority (RTA), 2011; Thomas et al., 2018; Urban Land Institute (ULI), 2003; White and McDaniel, 1999).

San Francisco, CA, has eliminated minimum parking requirements in the downtown and requires unbundled parking throughout the city (not required but encouraged for rental housing). For example, the city provided a zoning variance to a 141-unit apartment complex, allowing only 51 parking spaces rather than the required 141 because of unbundled parking and two car-sharing spaces. Boston, MA, also allows reduced automobile parking in-lieu of car-sharing spaces. Similarly, Portland, OR, has waived minimum parking requirements within 500 feet of transit lines that provide a 20-minute service during peak hours. Furthermore, maximum parking required at these sites equals 0.7 spaces only per 1,000 square feet of floor area. Finally, the city allowed the

⁵ Through a TDR program, public agencies can preserve land in its current state in the designated areas (sending areas) by allowing landowners in these areas to sell their development rights to entities who can use these rights to increase development density in areas identified for high-intensity development (the receiving areas).

substitution of 14 required on-site parking with 56 bicycle parking spaces for an apartment complex (Pollack et al., 2010).

Design guidelines for TODs can promote design features that enhance aesthetic appeal and walkability. They can do so by prescribing a change of uses over time, the maximum limit on the front setback, minimum FARs, maximum parking limits, and grid-iron street patterns. Furthermore, they can require a fine-grained mix of uses, reduced street widths, and building setbacks. Furthermore, they can require garages in back alleys, street furniture, wide sidewalks, front porches, traffic calming devices, and colonnades and other pedestrian pathways (Arrington et al., 2008; Thomas et al., 2018; White and McDaniel, 1999). Other guidelines include designing at the human scale, creating spaces for various users and activities, connecting spaces, enhancing safety, and accommodating car movement and parking (Jacobson and Forsyth, 2008).

2.2.5. Role of transit agencies

Although most transit agencies in the US do not have extensive land use and zoning powers, they can use eminent domain to acquire land for transit purposes and can often use that land for TODs. Moreover, transit agencies have a significant inherent interest in promoting TODs since they gain from TODs' ridership benefits and lease revenues⁶ (Dumbaugh, 2004; Federal Transit Administration (FTA), 2016). Additionally, transit agencies and local governments can leverage each other's land use and regulatory powers through cooperative agreements to facilitate land assembly, flexible or relaxed zoning, expedited permit processing, and land use-transportation coordination (Belzer and Autler, 2002; Cervero et al., 2002; Renne et al. 2011; White and McDaniel, 1999). Finally, transit agencies could also play a dual educational-advocacy role. For example, Santa Clara Valley Transportation Authority (VTA) in Santa Clara County, CA, has developed playbooks for station areas that, among others, provide detailed urban design, land use, and zoning-related strategies to promote TODs in their station areas (Santa Clara Valley Transportation Authority (VTA), 2020).

Table 3 summarizes the role of various levels of governments and transit agencies.

3. Surveys

3.1. Survey overview

Thirty transit agencies and 25 local governments (cities or counties) completed the surveys for response rates of 30% (30 out of 101) and 31% (25 out of 82), respectively. The responses are fairly evenly distributed by transit system size. For the transit agency surveys, 19% surveys are from transit agencies in the 1st quartile (bottom 25% of agencies) by size, 23% in the 2nd quartile (26% to 50% percentile), 26% in the 3rd quartile (51% to 75% percentile) and 32% in the 4th quartile (top 25% of agencies). The one-sample chi-square test for this distribution is statistically insignificant ($p = 0.307$), indicating that the distribution of the transit agency surveys by the transit system size is not statistically significantly different from even distribution.

For the local government surveys, five cities (20%) located in the service areas of the smallest transit agencies (1st quartile) responded to the local government survey, compared to 7 (28%), 7 (28%), and 6 (24%) in the 2nd, 3rd, and 4th quartiles, respectively. With a $p = 0.93$ on the one-sample chi-square test, the distribution of the local government surveys by the transit system size is also not statistically significantly different from even distribution.

Regarding the geographical distribution of the survey respondents, with a p -value of 0.16, the one-sample chi-square test shows that the

⁶ In cases where transit agencies develop TODs on their own or as joint development projects or lease land or air rights to private developers to construct TODs.

Table 3

Insights from Literature: Strategies Used by Government and Transit Agencies to Address PLUZ Barriers.

Government or transit agency	Strategies
Federal government	Advocacy of TOD as a value capture tool FTA guidelines on using land bought from FTA assistance for TODs Promote land use-transportation coordination through transportation funding TOD planning grants
State governments	Direct legislation to implement TODs Legislation supporting objectives co-aligned with TOD (e.g., compact development and affordable housing) Planning and infrastructure assistance Legal and policy framework for regions and localities (e.g., GM programs)
Regional agencies	Facilitate land use-transportation coordination Regional vision, plans, policies, guidelines, and standards Fund TOD planning
Local governments (cities/towns)	Ordinances Comprehensive, neighborhood, and station-area plans Revisions to zoning and building codes Financial and other incentives Power of eminent domain Cooperative agreements with transit agencies and other local governments
Transit Agencies	Power of eminent domain to acquire land for transit purposes Cooperative agreements with local governments Educational-advocacy role

transit survey respondents are evenly distributed across the four regions—North-East, Mid-West, South, and West—of the US. However, local government surveys show clustering with a larger proportion of surveys received from the West and the North-East. We received a little over half (52%) of the surveys from the West, while we sent out one-third (33%) of the surveys to this region's local governments. The corresponding percentages for the North-East were 24% (surveys received) and 15% (surveys sent). The South is underrepresented with 12% (surveys received) and 34% (surveys sent).

Both local governments and transit agencies began with answering questions aimed at estimating the prevalence of TODs nationwide and the existence of formal programs and other ways these agencies facilitate TODs. The next set of questions inquired about the various aspects of PLUZ barriers faced and how these agencies are addressing the barriers. For example, closed-ended questions asked respondents to rank on a scale of 1 to 5 the PLUZ tools used by their agencies to promote TODs. Open-ended questions inquired about the federal, state, regional, or local policies, plans, funding programs, and financial incentives that positively or negatively impact how their agency approaches land use and zoning in implementing TODs. Another set of questions focused on cooperative agreements and collaborative arrangements to promote TOD-supportive land use and zoning.⁷

3.2. Key survey insights

3.2.1. The large prevalence of TODs and TOD programs

The surveys show a substantial prevalence of TODs nationwide, with over 80% of local governments and transit agencies indicating at least one TOD in their service area. Furthermore, around half (48%) of the transit agencies and three-quarters (74%) of the local governments note the existence of formal programs in their agency to promote TODs. This large involvement of public agencies contrasts with the findings from a two-decade-old survey of national transit agencies that found very few

⁷ The survey questionnaires would be provided upon request.

transit agencies were involved in TOD projects (White and McDaniel, 1999).

3.2.2. Land use and zoning restrictions are impediments to implementing TODs

More than three-quarters (79%) of the transit agencies and around half (45%) of the local governments note that land use and zoning restrictions are highly impedimentary or somewhat impedimentary. The higher percentage for the transit agencies could be due to the minimal control these agencies usually have over land use and zoning around station areas. Furthermore, only half of the transit agencies and little over one-third (38%) of the local governments note that these impediments have been overcome.

3.2.3. PLUZ barriers

Surveys echo many of the literature review findings on the PLUZ barriers, especially those about complicated building permitting processes, transit agencies' lack of land use and zoning powers, a lack of coordination between transit agencies and local governments on PLUZ-related issues, and a lack of state-level support. For example, focusing on the permitting processes, many survey respondents from California noted that the state's environmental protection act, CEQA, results in a lengthy, confusing, and expensive permitting process. It also creates a constant threat of lawsuits that can derail projects.

Transit agencies across the country identified their lack of land use and zoning powers as the most common barrier. Over three-quarters of them rely on local governments to take the lead on land use and zoning matters; however, only about one-quarter of the local governments note that they address land use and zoning-related issues in partnership with transit agencies. The fact that only a small minority of transit agencies and local governments report the existence of cooperative agreements to implement TODs further points to this lack of partnership. Transit agencies plan for and implement transit system development, extension, and service improvements. Therefore, it is concerning that only a small proportion of local governments partner with transit agencies to address land use and zoning-related issues, thus signifying a need for a robust regulatory framework and a set of incentives to foster such partnerships. In the absence of cooperative agreements, transit agencies and local governments rely on looser, collaborative arrangements. Public sector inter-agency committees or working groups are the most used collaborative arrangement for the transit agencies and public-sector organizations or committees (such as a technical advisory committee and a council of governments) for the local governments.

Furthermore, many transit agencies are only allowed to acquire land for transit, not for TODs. Therefore, state legislative action is often needed. For example, before the Assembly Bill (AB) 670, which passed in 1999, allowed three transit agencies in the San Francisco Bay Area, CA, to acquire land to construct TODs (Assembly Committee on Transportation (ACT), 2000), these agencies could not do so. Still, many other transit agencies in California and across the country cannot acquire land for TODs.

Further highlighting the need for state legislation, the Metropolitan Atlanta Rapid Transit Authority (MARTA) pointed to Georgia's lack of state laws that encourage TOD-supportive land use. Salt Lake City, UT, noted the state's lack of teeth or incentives to encourage local governments to adopt TOD-supportive policies. For example, recently, the state started requiring more housing, which they loosely tied to transportation funding. The city further noted that while the regional plans include such policies, following them is optional.

Continuing the focus on the states' role, San Jose, CA, noted that state laws could reduce discretion and public engagement. For example, local laws can facilitate development by allowing developers to pay fees instead of providing affordable housing units in a TOD. However, state laws might prohibit such a waiver. Therefore, developers may decide not to construct such TODs at all. Reno, NV, notes that the Southern Nevada Public Land Management Act emphasizes market investment in the

suburbs at the expense of redevelopment and infill, thereby hindering the construction of TODs.

Overall, the surveys emphasized the need for an active role by states and regions. This need is underscored by the fact that only a little over half of the local governments and transit agencies noted the existence of a statewide vision, policy, or plan for TODs. Moreover, less than half of them noted the presence of statewide or regional GM policies or tools such as UGBs, concurrency, consistency, and identification of growth areas with TODs promoted inside them.

3.2.4. Strategies to address PLUZ barriers

Growth management/smart growth strategies at the municipal, regional or state level: Echoing the literature, survey respondents highlight the critical role of state-level GM programs. The transit agencies and the cities located in the states with state-level GM programs noted the state and regional-level laws, policies, and plans to encourage TODs. They also pointed to the emphasis of these programs on closer land use-transportation coordination, with TODs key to achieving GM objectives.

Land use and zoning tools: The surveys provide additional support for many literature review findings and provide a nuanced description of the tools' use. Respondents noted that the station-area zoning reforms are overcoming land use and zoning-related barriers. These reforms include relaxed parking requirements; parking maximums, not minimums; zoning for TODs (allowing compact, mixed uses); and density bonus programs. These responses are consistent with the top-three land use and zoning tools noted by the cities and the transit agencies to implement TODs, which include (in the decreasing order) mixed-use zoning, relaxed parking standards, and zoning for compact housing (see Fig. 1). These most-used tools are largely consistent with those noted in the White and McDaniel's (1999) survey of transit agencies: mixed-use zoning, density increases, and adding transit-supportive land uses along the rail lines and rail stations. See Table 4 for the list of land use and zoning tools offered as options in the surveys.

Survey results also show some consistency between local governments' and transit agencies' opinions on the least used land use and zoning tools. For example, the use of eminent domain (other than for right-of-way acquisition) is noted as the least used tool by both transit agencies and local governments. Less than one-quarter (23%) of transit agencies and 10% of local governments report its use. The use of TDRs is also among the least used in both surveys. However, while assistance with land assembly is among the least used tools noted by the transit agencies, the cities noted reduced permit fees. See Figs. 2 and 3.

The sparse use of reduced permit fees could be due to the constrained municipal budgets. Similarly, eminent domain's limited use is perhaps due to a lack of political will since this tool could be unpopular among the voter-property owners. Land assembly is time-consuming. It also requires significant technical capacity to conduct negotiations and develop the financial and legal structures needed to assemble land. Furthermore, eminent domain and land assembly often need to be used together because a TOD project could stall if even one small land parcel owner refuses to sell land. This need for simultaneous use of these tools likely makes their use even sparse. However, these tools are among the more effective ways public agencies can help TOD developers if used. Finally, the sparse use of TDR programs could be because its successful implementation likely requires a robust real estate market and significant institutional capacity, technical knowledge, and time and staff resources.

Finally, the City of Everett, WA, highlighted the program-design issues with some of these tools. For example, Washington State's Landscape Conservation and Local Infrastructure Program allows cities in the Puget Sound Region to receive a portion of the property tax revenue resulting from new development the cities attract in their local infrastructure project areas. The cities do this through a regional TDR program (Washington State Senate, 2011). However, cities usually allow generous density near transit. Therefore, there is little need for

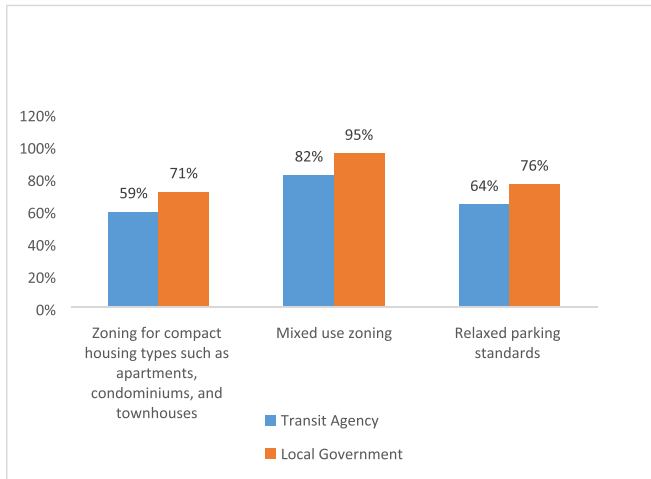


Fig. 1. Most frequently used land use and zoning tools for promoting TODs.

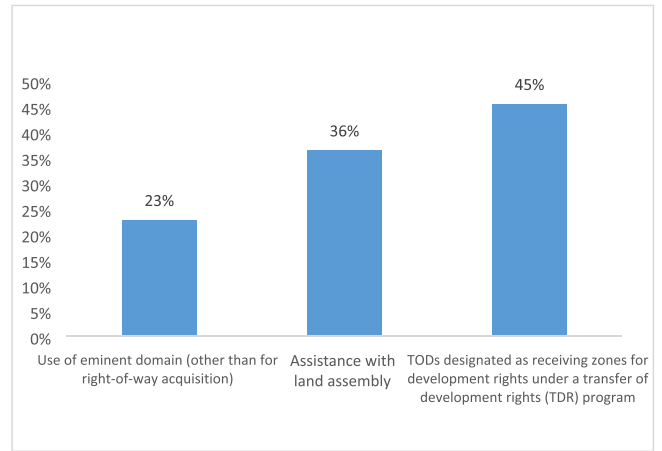


Fig. 2. Least land use and zoning tools for promoting TODs: transit agency survey.

Table 4

Survey options for planning, land use, and zoning tools and techniques to promote TODs.

Planning tools	Land use and zoning tools
TOD overlay zoning	Maximum, not minimum, lot sizes for single-family residences
TOD specific plans	Density bonuses ¹
Transit/urban village plans	Higher floor area ratio
Developer agreements	Relaxation of limitations on building height
Planned unit (PUD) process	Zoning for compact housing types such as apartments, condominiums, and townhouses
Others	Mixed use zoning Regulations and incentives that facilitate adaptive reuse of properties that would otherwise not meet the current zoning and/or building codes Requiring housing at various affordability levels through programs such as inclusionary housing Parking regulations that prescribe maximum, not minimum, parking requirements Relaxed parking standards ¹ Restricted off-street parking Incentives for shared and paid parking Transit agencies have the power to enter into joint development agreements with private developers Unambiguously specifying the kinds of actions permissible under joint development agreements; for example, whether transit agencies can grant development and easement rights to private entities Other developer incentives such as impact fees Streamlined/expedited environmental review Streamlined/expedited building permit approval Use of eminent domain (other than for right-of-way acquisition) ¹ Assistance with land assembly ¹ Exclusion of TODs from concurrency or level of service standards ¹ TODs designated as “receiving zones” for development rights under a transfer of development rights (TDR) program with areas outside the TODs designated as “sending areas” Others

¹ Source: Cervero et al. (2004), page A-17.

developers to buy TDR credits to develop near transit.

3.2.5. Most used planning techniques

The survey asked the respondents to note the most used planning techniques to promote TODs. The TOD-specific plans and developer agreements were common in both surveys. To round off the top-3, local

governments reported TOD overlay zoning (it was their top choice), while transit agencies reported the planned unit development process (it was their 3rd choice). See Figs. 4 and 5. See Table 2 for the list of planning techniques offered as options in the surveys. Notably, the transit/urban village plans do not make the top-three in both the surveys. This sparse use is perhaps indicative of the tool’s unproven effectiveness or a lack of integration of TOD planning with the comprehensive planning processes—a PLUZ barrier noted by Cervero et al. (2002).

3.2.6. Helpful state legislation

Survey respondents noted several pieces of state legislation that help address PLUZ barriers. These pieces of legislation can be divided into two categories—those that grant local governments or transit agencies power to develop TODs and those that allow them to achieve TOD-aligned objectives, such as affordable housing and streamlined permitting.

An example of the first category includes legislation that allows the San Francisco Bay Area Rapid Transit District (BART) to set minimum height, density, parking, and FAR requirements for developing TODs on land parcels it owns within one half-mile of its stations. This legislation also mandates that if the city’s zoning is inconsistent with BART’s, the latter’s will prevail (Chiu, 2017). Other pieces of TOD-specific legislation are in Connecticut and Tennessee. Connecticut grants authority to the state DOT to participate in TOD projects. Tennessee allows housing agencies to carry out TOD redevelopment projects in transit-deficient areas and toward that end to acquire, clear, and sell/lease land/property; borrow money; and receive federal grants. These housing agencies can also use eminent domain to acquire land for constructing public infrastructure/facilities such as transit lines and employ tax increment financing to fund redevelopment projects (Dickerson, 2017). Finally, VTA in Santa Clara County, CA, has the authority to undertake joint development TOD projects, including the use of eminent domain to acquire land for TODs.

The second category of legislation includes the recent pieces of legislation passed in California that encourage denser, mixed-use housing and infill developments. For example, they require zoning to be consistent with the city’s general plan and allow development to occur even if zoning does not support it, but the general plan does. Another piece of legislation requires California cities and counties that do not provide their share of housing to streamline the approval process for affordable multi-family housing and free it from being subject to a conditional use permit. Similarly, legislation in Utah promotes housing for all income levels and encourages housing-transportation coordination. Specifically, local governments need to prepare a moderate-income housing (MIH) plan as a section of their general plan. A local

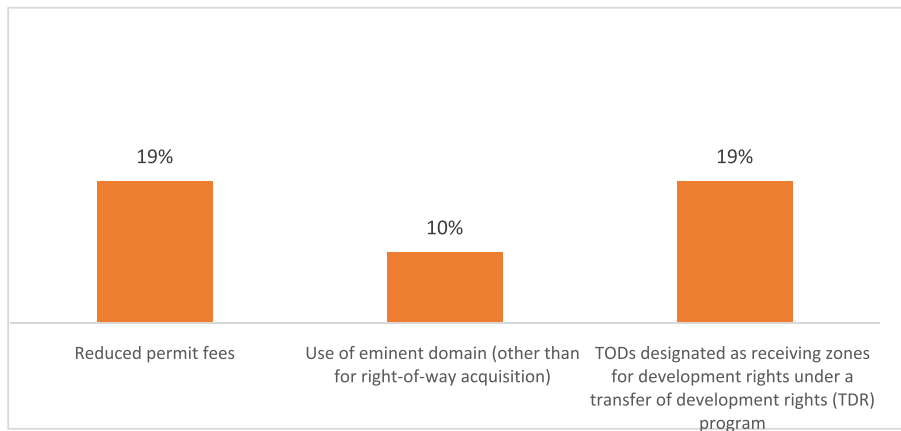


Fig. 3. Least land use and zoning tools for promoting TODs: local government survey.

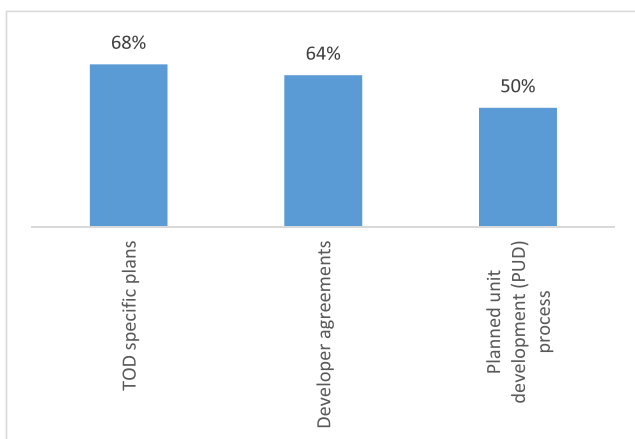


Fig. 4. Top-three planning techniques used to promote TODs: transit agency survey.

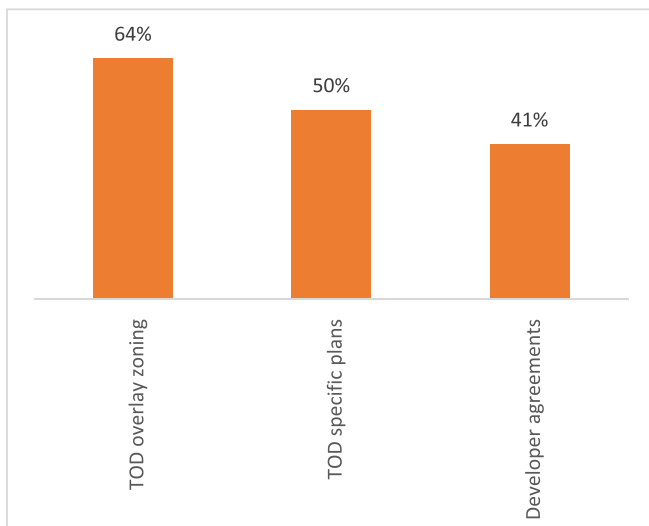


Fig. 5. Top-three planning techniques used to promote TODs: local government survey.

government that is required to report on implementing its MIH plan annually should satisfy these requirements to remain eligible for state transportation funds (Anderegg and Porter, 2019). State legislation in Nevada allows the creation of zoning districts. It provides various tools

to promote affordable housing, including donating/leasing/selling city or county land for affordable housing and establishing a process to expedite the approval of plans and specifications that help maintain and develop affordable housing.

3.2.7. Sparse use of direct financial incentives

Only one respondent noted the use of financial incentives to promote TODs. Specifically, BART’s station access program includes a “safe routes to transit” match funding offer to cities trying to improve pedestrian and bicycle safety for roads around the stations.

4. Discussion

This section discusses the key insights derived from the synthesis of the literature review and survey findings. It focuses on insights gained since the last comprehensive studies of the late 1990s and early 2000s (Belzer and Autler, 2002; Cervero et al., 2002; Cervero et al., 2004; Porter, 1997). Wherever the insights lead to recommendations to address PLUZ barriers, we have provided the recommendations along with the insights.

4.1. Key insights and associated recommendations

4.1.1. Growing interest among transit agencies but limited powers

While the surveys and literature find growing interest and involvement of transit agencies in implementing TODs, many barriers restrict their role. Two such barriers are a lack of land use and zoning power over the station and station-area land and a lack of ability to acquire land for TODs.

Pieces of legislation from California that grant BART land use and zoning powers over station-area land and the power to some transit agencies such as VTA to use eminent domain to acquire land for TODs are a good start. However, such pieces of legislation must ensure that transit agencies use land use and zoning powers judiciously to implement TODs. For example, the legislation could make the exercise of such powers contingent on periodic approval of transit agencies’ TOD plans by a state- or regional-level agency. In another variant, transit agencies and local governments can jointly zone for station areas and develop land acquisition plans.

Designating TODs transit infrastructure can build upon these legislative efforts. This designation will allow transit agencies to use transportation funds to acquire land for TODs as they do for other transit infrastructure such as stations and rail right-of-way. If the transit agencies own land for TODs, they will be in a better position to leverage strong cooperative agreements with local governments rather than the weak collaborative arrangements on which they currently rely. This designation will also enable the use of transportation funds to acquire

land for TODs. On the flip side, such a designation would likely spread the scarce public transportation funds thin.

Such land use and zoning powers, combined with the eminent domain power and designation of TODs as transit infrastructure, will enable transit agencies to incorporate TODs in their medium and long-range transit plans and make them an integral tool to promote transit ridership.

4.1.2. *Need for local governments to actively use eminent domain to assemble land for TODs*

The literature notes the need to use eminent domain and to help developers assemble land for constructing TODs, especially in already urbanized, inner-city, and infill locations. However, the surveys find that eminent domain is among the least used tools by the local governments. Therefore, local governments need to be more proactive in its use and assist TOD developers with land assembly. For example, California redevelopment agencies used these tools very often to facilitate TODs in redevelopment areas. The use of eminent domain became uncertain after the year 2005 *Kelo v. New London* Supreme Court case. However, in subsequent litigation related to the use of eminent domain for constructing TODs, courts have ruled that its use is a legitimate use of police power for public benefit (Renne et al., 2011). Still, the local governments are likely to face voter-property owner opposition.

4.1.3. *Active ground floor and flexible land use and zoning*

Literature notes that local governments often require ground-floor retail in TODs, usually more than the market can support. This oversupply results in high retail vacancy in TODs, which, in turn, reduces the urban vitality and financial viability of TODs. Furthermore, the literature notes inflexible land use and zoning as a barrier. In the interviews conducted as a follow-up to the surveys, a representative from BART emphasized the need to shift from requiring ground floor retail to requiring active ground floor uses. Furthermore, developers should have the flexibility to choose from a menu of uses, such as live-work-spaces, retail, and offices; and for the uses to change over time. However, due to the fiscalization of land use, local governments might be tempted to reduce the menu to fiscally advantageous uses.

Flexible zoning that allows active ground floor has twin benefits. First, it increases TODs' marketability, which in turn, will promote TOD construction. Second, lower vacancy rates should result in higher transit ridership.

4.1.4. *A more nuanced understanding of the dimensions (Ds) of the built environment and its occupants*

Various dimensions (Ds) of the built environment (and its occupants) impact transit ridership. These Ds include design, which the earlier literature measured as the connectivity of the street network. Furthermore, the interactions between the Ds were not well understood. However, more recent literature has advanced on both fronts. High-quality urban design, not just street connectivity, is considered key to a successful transit-oriented urban form. Finally, we now have a better understanding of the interactions between various Ds (such as density and diversity) and other factors such as parking and pedestrian-friendly environment. In summary, compact TODs with high aesthetic quality, right-sized parking, and pedestrian-friendly design should help increase TODs' marketability and transit ridership.

4.1.5. *Greater sophistication in parking strategies*

Literature has detailed parking-related barriers to TODs and offered solutions such as maximum, not minimum parking; and shared, unbundled, and distributed parking. More recent literature and surveys provide examples of more sophisticated ways local governments and transit agencies are addressing parking-related barriers. These examples include lowering parking requirements if car-sharing spaces are provided, linking parking requirements to the transit service level, substituting automobile parking with bicycle parking, and developing

parking requirements based on transit stations' characteristics and the station areas' needs. We recommend the widespread dissemination of information on such parking-related strategies because these parking strategies should lower the cost of implementing TODs, create a pedestrian-friendly environment, and promote transit ridership.

4.1.6. *Need for greater direct financial incentives*

The literature calls for financial incentives to remove various barriers to implementing TODs. Very few direct financial incentives exist, however. For example, the surveys found only one: BART's funding to cities to promote a walk- and bike-friendly environment around stations. In addition, the federal government has only recently started providing TOD planning grants. Finally, federal and state financial assistance, such as infrastructure or community development grants, could be used for TODs. Given the significant financial implications of PLUZ barriers that TODs face (for example, costly environmental review process and specific plans), it is essential to scale up direct financial assistance for TODs. Moreover, given the fiscally constrained local government budgets, this strategy is more likely to work if the state and federal governments provide these incentives. If successful, these incentives should lower the risk and cost of implementing TODs.

4.1.7. *Greater efforts are required to establish TOD as a tool to link housing, especially affordable housing, with transportation*

The extant literature, especially the stream focusing on eTODs, has begun to position TODs as key to linking housing with transportation. This stream of literature also advocates for affordable housing in TODs because low-income households are more likely to use transit than higher-income households. The literature and surveys reveal a sprinkling of state and regional efforts underway to promote TODs as the key to strengthening this linkage. For example, Tennessee's legislation grants powers to housing agencies to acquire, clear, and sell/lease land/property; borrow money; and receive federal grants to implement TOD redevelopment projects in transit-deficient areas. In another model, MTC provides financial incentives to developers for including affordable housing in TODs. Such efforts should be promoted nationwide. Moreover, given the large subsidies are often required to provide affordable housing to low and very low-income groups, the financial incentives are likely to need large financial outlays. As most local governments are cash-strapped local governments, state and federal assistance is likely required for this strategy to work.

4.1.8. *Need for states' leadership*

The literature and the surveys highlight the critical role states could play in addressing PLUZ barriers through legislation, policies, programs, and financial assistance. However, surveys also provide an example of where state legislation can hinder TOD implementation. For example, local laws could allow developers to pay fees in lieu of providing affordable housing units in a TOD, but the state laws might prohibit such a waiver. Therefore, states could take a proactive role in addressing such inconsistencies through legislative amendments, thereby overcoming PLUZ barriers and removing obstacles to implementing TODs.

5. Conclusions

Two interconnected forces have led to an increased impetus toward TODs in the US in the last few decades. First, many states and metropolitan areas across the US have developed or are expanding transit systems. Such examples include streetcar systems in Dallas, TX, Seattle, WA, and Portland, OR; and the extension of BART to Silicon Valley in California. Second, the federal government continues to reinforce the need to integrate land use and transportation by promoting transit and TODs. However, major barriers to TODs exist, including PLUZ barriers.

This paper first reviews the extant literature to briefly overview the various barriers faced in implementing TODs in the US. These barriers can be broadly divided into two groups—non-PLUZ and PLUZ barriers.

The non-PLUZ barriers include economic and financial/fiscal barriers, organizational/institutional barriers, political barriers, policy barriers, and regulatory barriers. Next, the literature review focuses on the PLUZ barriers and the strategies to address them. The PLUZ barriers include the lack of regional and local planning, zoning barriers, and urban design barriers. The strategies to address them are grouped by the role of federal, state, regional, and local governments; and transit agencies in implementing them.

Next, the paper summarizes the findings of two US-wide surveys and discusses the current, on-the-ground views of the two agencies at the forefront of constructing TODs—transit agencies and local governments—about the barriers and ways to address them. First, the survey finds a significant prevalence of TODs and TOD programs across the US. Second, around half of the local governments and three-quarters of the transit agencies note that land use and zoning restrictions impede the implementation of TODs. Third, complicated building processes and a lack of coordination between transit agencies and local governments on PLUZ-related issues are barriers to TOD implementation. Fourth, transit agencies note their lack of land use and zoning powers as a major PLUZ barrier. Finally, mixed-use zoning, relaxed parking standards and zoning for TODs are the most used land use and planning tools to overcome PLUZ-related barriers. At the same time, the use of eminent domain and TDR programs are used the least. Among the planning tools, local government and transit agencies use TOD specific plans and developer agreements most.

Finally, the paper provides a set of insights and recommendations. The major recommendations include the need to consider TOD as a transit infrastructure, not just a transit-supportive use in transportation funding programs; the need to shift from requiring ground floor retail in TODs to focusing on an active ground floor; support the active role of transit agencies in implementing TODs through the grant of land use and zoning powers and incentives for local governments and transit agencies to enter into strong cooperative agreements; the need for a more active role of local governments in assembling land for TODs; design TODs that have high aesthetic appeal, recognizing that design elements of the built environment that promote transit ridership go beyond street connectivity and include the urban design of TODs; and support efforts to provide affordable housing in TODs by recognizing TODs as key to linking housing with transportation.

The paper advances existing research in four significant ways. First, it consolidates the discussion of PLUZ barriers, allowing greater focus on the barriers and the ways to address them. Second, it provides an updated review of academic and policy literature on these barriers. Third, it discusses the views of transit agencies and local governments on PLUZ barriers and strategies and tools to address them. Moreover, while conducting this study, we identified a few opportunities for future research, such as in-depth studies of TOD projects that overcame significant PLUZ barriers. These studies can identify the barriers; the specific strategies and tools employed to overcome them; and discuss whether and how overcoming the barriers improved TOD outcomes such as transit ridership, design quality, pedestrian-friendly built form, and connectivity to the transit station. Furthermore, future research could assess the comparative effectiveness of the various tools and strategies to overcome PLUZ barriers and research the reasons for the sparse use of some of them. For example, is the limited use of eminent domain and land assembly because they are deemed less effective, or is it because they are politically and administratively difficult to implement?⁸

Finally, researchers can also conduct a nationwide analysis of the pieces of state-level legislation that directly or indirectly address PLUZ barriers. For example, are some states better at providing land use and zoning powers to transit agencies through legislation? If yes, what are the key features of their pieces of legislation that other states might

consider adopting?

CRediT authorship contribution statement

Shishir Mathur: Conceptualization, Methodology, Writing – original draft, Writing – review & editing, Visualization, Formal analysis, Supervision, Project administration, Funding acquisition. **Aaron Gatlula:** Formal analysis, Writing – original draft, Writing – review & editing, Visualization.

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