

Bus Transit Oriented Development— Strengths and Challenges Relative to Rail

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Abstract

While rail has been the focus of most planning for Transit Oriented Development (TOD), there has been recent interest in bus-related TOD with an emphasis on new bus rapid transit (BRT) systems in North and South America and Australia. This article takes a critical look at the strengths and challenges of bus-based transit systems compared to rail in relation to TOD. It includes a review of the literature and an assessment of TOD-related developments. The performance of BRT systems in relation to TOD is considered with specific reference to BRT systems in Australia. In addition, TOD related to local suburban bus service is examined. The article describes the general concept of TOD and how this relates to features of transit modes, outlines the literature relevant to bus-based TOD, and identifies the strengths and challenges of bus-based transit systems in relation to TOD. It concludes by summarizing the relative strengths and challenges of BRT and local bus services compared to rail. The findings of the review are used to identify ways in which bus-based TOD might be better planned and implemented.

Introduction

Transit Oriented Development (TOD) is a significant way of improving the effectiveness of transit as well as supporting community goals and improving accessibility (Cervero et al. 2004). In general, TOD initiatives have focused on rail TOD (RTOD); bus TOD (BTOD) is clearly a minor subset of TOD implementation and is not well covered in the research literature (Cervero et al. 2004). There is evidence of an increase in the profile of BTOD. BTOD is seen as an important feature of the growing bus rapid transit (BRT) field (Levinson et al. 2003). Almost 8 percent of the TOD initiatives identified in a U.S. survey were BTODs (Cervero et al. 2004). So what is the potential for TOD in relation to bus services? How far can TOD be realistically applied in the bus industry?

This article identifies the strengths and challenges of BTOD through a literature review and an assessment of development experience.¹ It provides an objective assessment of the capabilities and issues of bus in relation to TOD. Comparative assessment to rail is undertaken as a means of exploring these issues (not to advocate bus in preference to rail or vice versa).

Assessing the relative merits of bus and rail requires some generalizations regarding the nature of these modes. In practice there are a very wide range of bus/rail service types. The article considers bus in two forms.

- BRT with an emphasis on frequent, high-quality mass transit systems with much fixed infrastructure including stations/guideways, and
- local/suburban bus with low frequency services operating on-street in suburban settings with minimal fixed infrastructure.

In general, rail services examined refer to urban commuter mass transit systems.

Market climate and development opportunity are key success factors in TOD (Cervero et al. 2004) rather than the relative features of rail versus bus. This article examines bus/rail issues in isolation of these factors as a means of exploring modal influences on TOD. However, it is recognized that financing and risk assessment will remain principal factors affecting TOD regardless of the transit mode involved.

The article begins with an overview of the BTOD literature. Challenges of BTOD compared to rail are then discussed followed by a discussion of strengths. The conclusion summarizes key findings and discusses ways in which BTOD might be better planned.

Research Literature

A casual reader of the TOD literature might be forgiven for thinking that bus services play no role in the field. However, bus-based TOD has been identified in typologies of TOD characteristics. Calthorpe (1993) identified both an “urban TOD” associated with rail stations and a “neighborhood TOD” associated with bus. Dittmar and Ohland (2004) suggest a hierarchy of transit modes related to a hierarchy of TOD types. While bus services are provided at every level, rail is more closely related to high-density/large-scale development and bus with low density/small-scale development. This is repeated in much of the literature. The term “development oriented transit” (i.e., associating low density with bus) has also been associated with this. A review of TOD residential density thresholds (Cervero et al. 2004) identified consistently lower density expectations for bus than light rail in San Diego, Portland, and Washington County, Oregon.

The collocation of bus services and bus terminals at some major rail stations has been suggested as a potential spur for TOD (Porter 1997). BTOD was also commonly associated with bus stations in cities without rail.

BTOD is more commonly associated with busways or BRT. The ability of large-scale bus transit systems to encourage land development has been identified as a major benefit of these forms of transit technology (Levinson et al. 2003).

The Ottawa transit system is a major icon of BTOD. Ottawa’s policy of combining integration of land use and transport planning with an emphasis on transit development over road construction is to be admired regardless of the transit modes involved. Nevertheless, it was a busway that achieved densification of development around busway stations (Bonsall 1997).

Curitiba and Bogotá are the other major icons of both BRT and associated BTOD. Evidence of development benefits of these systems has been identified (Rodriguez and Targa 2004; Smith and Raemaekers 1998).

While BTOD has been successful with large-scale BRT, the relevance of these examples is questionable. Henry (1989) notes strong land-use controls as a major factor influencing successful TOD in Ottawa. This level of control is considered “formidable” and “most unlikely” in U.S. land-use planning.

So what is the practical and realizable potential for BTOD? The next sections consider BTOD challenges and strengths.

Challenges

This section addresses challenges or weaknesses of bus in relation to TOD relative to rail. In each case, the significance of challenges are graded as “low,” “medium” to “high,” based on a judgmental assessment of the arguments presented by the author. Where there is some uncertainty, this is indicated.

Permanence, Magnitude, and Implications for Development Risk

Many sources question the permanence of bus compared to rail. “Developers and home buyers alike seem to be attracted to the permanence of rail transit” (Dittmar and Ohland 2004). “Because the locations of bus routes are not fixed or permanent, this greatly increases the risk of investing in transit-supportive land-use development” (California Department of Transportation [CDOT] 2002).

Development scale and magnitude is purported to be significantly higher for rail than bus and is suggested as a major spur for RTOD compared to BTOD (CDOT 2002). Certainly, significant investment suggests significant commitment. Commitment and developer risks are linked. However, Hensher (1999) asks, “What makes for permanence?” He questions whether busways are less permanent than light rail since few busways have been removed. Niles and Nelson (1999) state, “It is not easy to draw the conclusion that rail transit is both more permanent and a greater attractor of development than is bus transit.” They note that historical studies demonstrate much change and evolution of transit systems of all types. Evidence is quoted of Chicago bus routes that have existed for almost a century. Reference is also made to the numerous streetcar systems removed in post-war North America.

Some conclusions emerge from these points.

- Suburban bus systems operating at low frequency with minimal fixed infrastructure lack magnitude and permanence for successful large-scale BTOD. This creates risk for large development. This is a concern of “high” significance.
- This does not mean that small/low density development is not possible or desirable in some cases where suburban buses operate.
- The argument that fixed rail infrastructure has more magnitude and permanence compared to busways is weak. The Ottawa system provides strong evidence to the contrary.

Newness

The “newness” of rail investments was cited by the CDOT (2002) as being a factor that provided an advantage over BTOD. An important difference between bus and rail is that rail (and light rail in particular) is often introduced as an entirely new mode and usually replaces an existing bus-based service. Most BRT systems replace local bus systems with vehicles that are also buses. Hence, while busways may have significant new infrastructure, they often employ the same bus vehicles on that infrastructure. While the development of some new bus vehicle types is an important part of BRT system design, few BRT systems use radically new-looking vehicles (e.g., the Australasian BRT systems) (Currie 2005c).

Newness is important to TOD where a significant change from existing obsolescent land uses is required; however, this is not a requirement for all TODs. Clearly, this issue is also of less relevance to large-scale BRT operations and systems employing new-looking vehicles (e.g., Civis). In contrast, TOD based on suburban bus with limited fixed infrastructure is likely to be a poor performer in relation to the newness factor particularly where TOD is focusing on urban renewal. This view conflicts with the experience of the Central Ohio Transit Authority (Duffy 2002) who cite the successful redevelopment of the Linden Center from the “worst case of urban blight” into a successful (local) bus based transit center. While there is some cause to identify newness as a factor reducing the effectiveness of particularly suburban bus, the significance of this factor in affecting the success of BTOD is likely to be “low” to “medium.”

Different Markets

It has been argued (CDOT 2002) that rail and bus riders are demographically different and that rail attracts “choice”² riders who tend to have higher incomes. It is suggested that rail can target a more affluent market for TOD investments and, hence, will be better suited to TOD in more affluent suburbs or successful downtown development.

Currie (2005c) compared demographic data from a series of Adelaide public transport corridors including the O-Bahn busway (BRT), on street bus and rail. Rail carried more choice passengers than on street bus. However, busway users tend to have characteristics more like rail markets than bus markets. This could suggest that the potential yield from BRT systems in terms of TOD development may be similar to rail.

Relationships between affluent riders and more successful TOD are unclear. While higher yield customers are good for any business, it does not follow that the market for TOD properties is well represented by higher income groups. Certainly in Australia there is no clear relationship between high development density and affluence. Indeed, the contrary is quite often the case.

In conclusion, local bus caters to different markets than rail; there are fewer choice and more low-income characteristics. Some researchers suggest that RTOD is more successful as a result. However, this supposition is not yet supported because of lack of evidence. This weakness is thus rated “low” and “questionable” on this basis.

Park and Ride

Park and ride (P&R) has been identified as a factor that limits TOD opportunities (Dittmar and Ohland 2004). More than 57 percent of rail transit agencies involved in U.S. TOD identified P&R as a moderate to significant factor affecting the success of TOD. The main concern is conflict between large parking lot needs, road capacity needs, the volume of car access, the desire for prime development space, and the need for quality uninterrupted walk access.

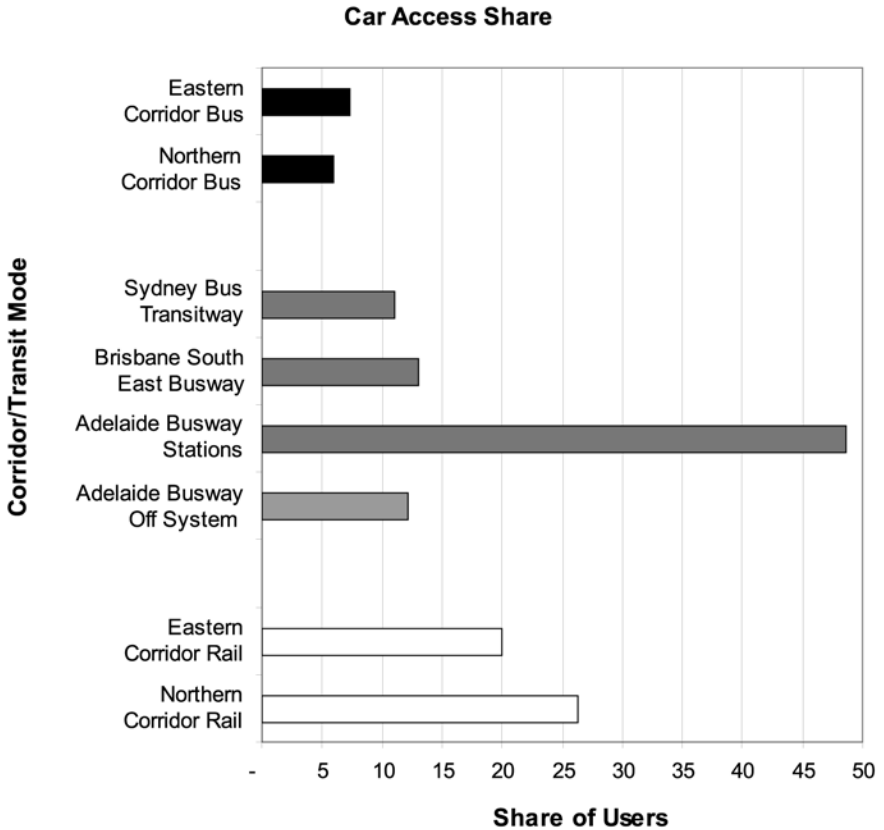
P&R is a significant access mode to rail, as well as to busways. Interestingly, as Figure 1 suggests, it is less of an influence on local bus than on rail or busways. Some BRT systems are P&R based and others are not. It could be argued that rail has a disadvantage in relation to P&R while bus has an advantage. However, the results suggest different systems have different characteristics and that generalizations about modes are unclear (and unhelpful).

The following conclusions are made:

- Rail and some BRT systems have high P&R access, which limits successful TOD.
- On-street bus has a low P&R access, which may be a benefit of BTOD over some RTODs.
- The design of BRT systems needs to exclude or manage P&R where BTOD is to be implemented.

Industry TOD Capabilities

There is some evidence that implementing successful BTOD is more difficult than RTOD. “Making bus TODs work will require a focused approach and an extra level of leadership and intervention than a comparable rail TOD” (CDOT 2002). A



Source: State Transport Authority (1992, 1994), Travers Morgan (1991), McCormick Rankin Cagney, (2002), Parsons Brinckerhoff (2005).

Figure 1. Comparative Share of Park and Ride Access—Adelaide Busway, Bus and Rail Corridors, Brisbane South East Busway and Sydney Transitways

review of TOD in the United States (Cervero et al. 2004) has found that only three percent of transit agencies engaged in BTOD had full-time staff to run BTOD programs. The proportion for rail agencies was 42 percent.

Lack of bus industry capabilities to manage BTOD is rated a “high” weakness in relation to BTOD.

Pedestrian Access

High-quality, grade-separated direct walk access is an important feature of successful TOD (Cervero et al. 2004). This can be difficult to achieve with bus. A bus station can have numerous lines with significant bus movements. Large bus vehicles operating at high frequency in streets with pedestrians can be dangerous. Their activity requires careful management and is certainly unattractive from an environmental, street quality, and amenity viewpoint.

Difficulties in providing quality pedestrian access are more likely to be an issue for local bus systems, particularly at major bus stations (where BTOD is often focused). Only a few BRT systems have addressed this problem.

The significance of the issue should probably be rated as “moderate” rather than “high.” While quality pedestrian access is a desirable part of successful TOD, there is no evidence that it is essential.

Parking Restraint

Parking restraint policies are a useful addition to TOD strategies. They enhance attractiveness by limiting road congestion and are useful in providing more land for development. Links between RTOD success and parking constraint have been identified (Porter 1997). Parking restraint is easier to apply in high-density, rail-based locations because the problems of excessive parking demand are evident. In lower density nodes (more typical of suburban bus), enacting parking restraint practices is difficult because problems of congestion are often less evident and bus service levels are low. Without a quality public transport alternative, it can be argued that parking restraint in smaller urban development is less justified.

The differential capability of bus and rail to influence parking restraint is probably influential only with suburban bus services. BRT-based systems should be able to justify higher density development where parking restraint is feasible.

The significance of this is probably “high” since parking restraint is an effective means of encouraging transit use. Car access can also have secondary influences on pedestrian quality and quality of the environment.

Urban Density

Urban density is the critical driver of transit ridership (Seskin and Cervero 1996). Luscher (1995) identified urban density as a key factor affecting TOD’s ability to reduce auto usage and noted that bus-based services tended to be provided in areas with lower density development. Bus services, notably suburban services, will

therefore be less successful at achieving patronage growth and in reducing private auto travel in TOD than rail. This is not necessarily true for BRT services, depending on the success of BRT in encouraging higher densities.

The significance of this factor is probably “moderate” to “high.” While suburban bus services may not achieve rail-like patronage, TOD can still occur. However, it is likely to have a less significant impact than that experienced for rail and BRT.

Scale Dilution

A potential disadvantage of BTOD is that it is difficult to concentrate development activity around the large number of bus stops in cities (e.g. 3,400 bus stops are identified in San Diego) (CDOT 2002) compared to the small number of rail (49 light rail stops). This effect is termed “scale dilution.”

There are two sides to this issue. While scale dilution appears plausible, it is also conceivable that concentration of TODs at a few sites is limiting. Luscher (1995) modelled the impacts of RTOD and BTOD projects in reducing auto use in San Francisco. A 5 percent reduction in auto VKMs was achieved with 82 RTODs combined with 246 BTODs. More than 60 percent of total reductions in VKMs occur because of BTODs not RTODs.³ Although each RTOD is more effective than a BTOD, the sheer volume of BTOD sites is so much larger than the RTOD’s that overall BTODs have a greater effect.

Scale dilution could reduce the effectiveness of RTODs. While there is no evidence of this, it is certainly an issue worth considering. Having the option of smaller scale BTODs as well as larger scale RTODs also provides greater choice for TOD developers and customers.

While scale dilution is an important issue for BOD, it is only likely to affect local bus systems. BRT stations should be as limited in number as rail stations. However, the significance of this issue to bus is probably “unimportant” to “low.” While the significantly larger number of sites for BTOD is a problem, it is also an opportunity for cities to obtain the higher benefit from TOD on a systemwide basis. It also increases the community’s range of choice.

Noise and Pollution

Noise and fumes emitted from transit vehicles are generally associated with bus, not rail. Rail usually has the advantage of “clean” electric power over diesel-based bus. While rail vehicles, particularly heavy rail vehicles, can often be noisier than buses, it is the closer on-street proximity of buses where pedestrians roam and

the frequency of bus movements that generates greater noise impact. Rail-based vehicles often generate noise on rights-of-way, which are remote from major pedestrian areas (e.g., tunnels).

There is some substance to this issue. Where buses use alternative fuels or operate in areas removed from pedestrians, these issues may not be so important. However, in general, this is rare.

The significance of this issue on the performance of BTOD is “moderate” to “high.” Successful TOD requires an environment in which people want to live and work. Bus noise and pollution, unless appropriately managed, creates places which are not attractive.

Frequency and Speed

Regarding TOD, Dittmar and Ohland (2004) note, “After density, the most important questions about transit have to do with service frequency and speed.” Rail tends to operate at higher frequencies than suburban bus. In addition, most modern rail systems operate in exclusive rights-of-way with long station spacing. Local bus tends to operate in mixed traffic with frequent stops. As a result, bus speeds are low compared to rail.

While low frequency and speed are valid concerns for local bus, they do not apply to BRT, although this depends on the degree of right-of-way segregation applied. Indeed, a positive attribute of BRT relative to rail is that service frequencies on busways are much higher than rail due to vehicle capacity and the number of vehicles required to meet demand. Many busways operate at headways below one minute, whereas rail services require longer headways due to larger vehicle capacity and train separation requirements. This can limit heavy rail systems to headways above two minutes.

The significance of this issue on local bus services is “moderate” to “high.” It is a strength, not a weakness relative to BRT. The impact of transit on development requires an effective service offering. Without this, the transit element of TOD has little to offer.

Bus Stigmatization

Buses have a bad image. “The bus rapid transit program is trying to change this, but buses are still stigmatized as second-class forms of transport” (CDOT 2002). A key question is: Does bus stigmatization affect potential TOD investors and TOD transit customers?

The effect on customers has been illustrated by Currie (2005a), who examined empirical evidence on how transit riders perceived travel by on-street bus, BRT, light rail and heavy rail. A preference for rail over on-street bus was evidenced; an average benefit valued at between 4 to 10 minutes of travel time was indicated. However, this work also demonstrated similar preferences for BRT compared to on-street bus (although BRT research evidence was limited). This suggests that BRT shares passenger preferences of rail above on-street bus.

This evidence does not concern investors in TOD. It is possible that TOD developers have negative views of bus compared to rail and that developers influence TOD as much as transit riders.

While the significance of bus stigmatization is currently “high,” it does not need to be a long-term issue. It is likely to afflict on-street local bus services more than BRT systems.

Track Record

BTOD does not have as long a record as RTOD. Also, little is known about the impacts of BTOD. Some doubt the performance of BTOD. “Experience in California, like the rest of the country, tends to be somewhat mixed regarding bus TODs” (CDOT 2002). Others provide positive reports (Duffy 2002; Cervero et al. 2004). Objective independent assessment of BTOD schemes is rare, so some caution is appropriate. Some are likely assessing the performance of BTOD, particularly BTOD associated with suburban bus, in similar terms to RTOD. The evidence from the discussion in this article suggests that local bus TODs are unlikely to perform as well as RTOD. But this does not mean that BTOD, in these circumstances, is not a positive program to implement.

Overall lack of a track record is considered to have “moderate” to “high” significance for all types of bus services. While it might be theorized that BRT is likely to show good performance relative to rail, evidence on its track record is limited.

Strengths

Complementarity and Ubiquitousness

Ubiquitousness is the converse of the scale dilution weakness. Luscher’s results (see earlier) demonstrated that BTOD can work alongside RTOD to achieve higher citywide TOD benefits than by operating RTOD schemes alone. In effect, BTOD and RTOD are complementary.

These comments must be tempered by doubts about the effectiveness and ease of implementation of numerous concurrent BTODs. Nevertheless, joint BTOD and RTOD approaches seem an appropriate package of TOD initiatives on a metropolitanwide basis.

The significance of these strengths is considered “high” for all forms of bus service.

Flexibility–Choice

Dittmar and Ohland (2004) suggested that BTOD schemes may be an attractive option where communities do not want high densities. They also suggest BRT as an interim step to build ridership, which may make rail transit more feasible. Both of these points suggest BTOD has elements of flexibility that RTOD may not demonstrate. For example, bus can better mimic the many-to-many nature of suburban trip patterns than rail.

The significance of these issues to BTOD must be “high,” particularly to communities looking for alternative options to high-density living. Overall flexibility should add an extra capability and strength to the TOD planning approach since a wider range of options for implementation are available.

Flexibility–Adaptiveness to Change

The ability to cost-effectively redesign and adapt BRT systems to changing market circumstances compared to rail has been highlighted by many researchers (e.g., CDOT 2002). Hensher (1999) notes a dichotomy between flexibility and permanence: “The cost of producing flexible service capable of potentially responding to changing geographic activity patterns is the price of reduced commitment to the facility.”

There is little research valuing the benefits of adaptability. However, there must be some benefit from providing a flexible planning future, particularly when futures are uncertain and capabilities to invest in expensive rail projects are limited. These points suggest a “moderate” significance rating for this BRT strength.

Cost-Effectiveness

Local bus services are more cost-effective in lower density areas than rail. In addition, there is evidence that BRT systems are more cost-effective to build and operate than light rail (U.S. General Accounting Office 2001). The case for cost-effectiveness in relation to heavy rail is less clear. The higher capacity of heavy rail could be too costly for buses to match.

Cost-effectiveness is possibly the most significant variable that can be associated with the assessment of transit systems. Thus, this benefit has a “high” significance.

Service Frequency

High frequency makes transit attractive in TOD. While frequency is a challenge for local bus, BRT can have superior frequency compared to rail. This strength is considered “high” but applies only to BRT systems. It is a weakness for suburban bus.

Transfers

An additional feature of busway-based BRT is that it often does not require passenger transfers to access the main trunk system since buses pick up in the suburbs then proceed onto the busway right-of-way without the need for a transfer between vehicles. It is impractical to run rail systems down every street in every suburb. Hence, feeder bus services are required, which generate passenger transfers. Passengers dislike transferring. Currie (2005a) collated international evidence on the perceived values of passenger transfers and found average transfer penalty values for bus-light rail of 19 minutes and bus-heavy rail of 13 minutes. Values of this order clearly have a significant impact on travel choices.

The capacity of some busways to reduce transfers is of some value compared to rail. However, this is only one of many parts of a journey; it only applies to certain markets (those making transfers) and also to particular BRT systems (where transfers are not required).

This strength is valued at “low” to “medium” significance.

Assessment of Strengths and Challenges

Figure 2 shows an assessment of the relative strengths and challenges of bus relative to rail. The significant challenges for effective BTOD are:

- poor bus industry capabilities,
- noise/pollution impacts of buses, and
- poor track record.

BRT systems have less significant weaknesses than local bus (P&R access is the only exception to this). There are far fewer strengths of bus compared to weaknesses. Nevertheless, many strengths have “high” significance. BRT has more strengths than local bus.

BRT with good design can lessen the significance of challenges. On this basis, well-designed BRT could have net advantages compared to rail in some circumstances—an interesting conclusion.

Conclusions

This article has identified the strengths and challenges of bus in relation to TOD. A large number of challenges have been identified. The lack of dedicated TOD development staff in the bus industry, the noise/pollution impacts of buses, and a poor track record of bus in relation to TOD were the most significant weaknesses identified for bus services as a whole.

It is clear that suburban bus services are more suited to lower density environments. It is also evident that successful implementation of BTOD is a more difficult task than related RTOD initiatives. Nevertheless, BTOD can provide an important complementary function in supporting both RTOD and BRT-based TOD programs by expanding the benefits of TOD on a more comprehensive scale.

This analysis has identified opportunities to improve BTOD planning.

- Bus industry capabilities and dedicated staffing for supporting BTOD initiatives need to be enhanced considerably. This problem is exacerbated by the lack of knowledge and experience in BTOD planning, implementation, and performance.
- While BRT systems are tackling the issue of bus stigmatization, it is important that these leanings “trickle down” into the more conventional bus-based services.
- Noise and pollution remain significant issues for bus. Separation of local bus services from pedestrian areas and use of nonpolluting fuels should be a priority for bus systems hoping to successfully adopt BTOD strategies.
- It may always be difficult for smaller-scale bus services to generate an impression of scale and permanence to large-scale development opportunities. This problem is best addressed at bus stations through innovative designs that challenge the concept of the bus station as a cold and unfriendly location.

A. LOCAL BUS

Strengths and Challenges/Weaknesses

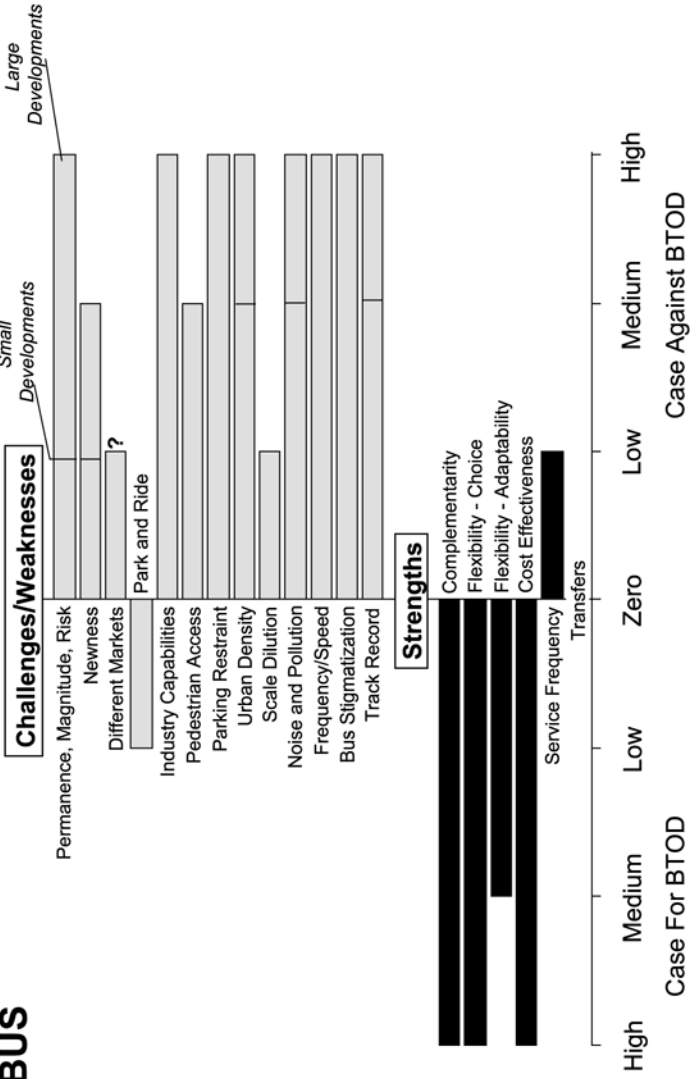
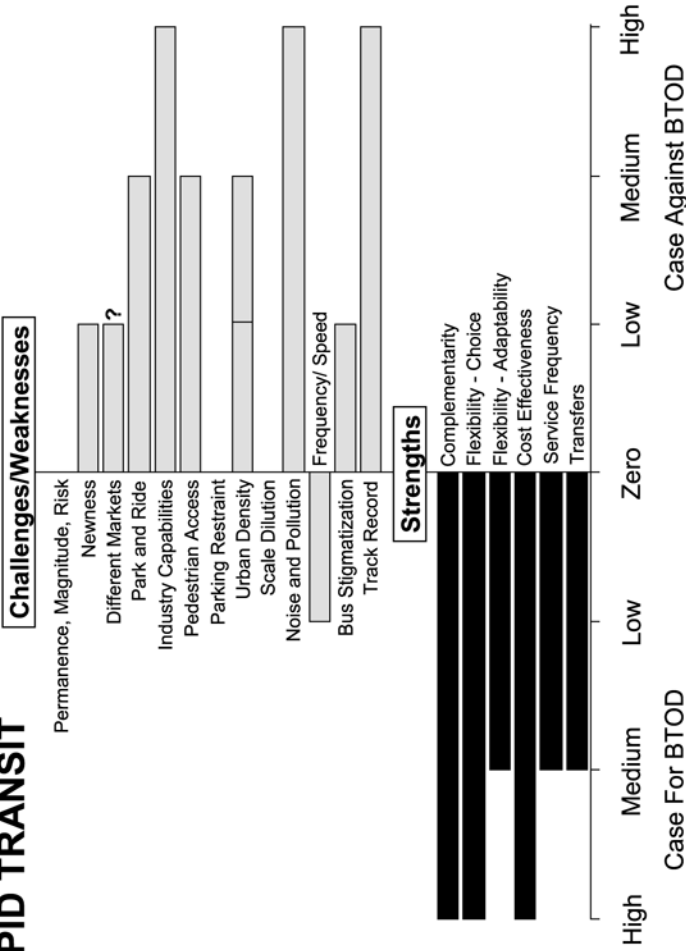


Figure 2 (A-C). Relative Strengths and Challenges of Types of Bus Service in Relation to Transit Oriented Development (cont.)

B. BUS RAPID TRANSIT



Strengths and Challenges/Weaknesses

Figure 2 (A-C). Relative Strengths and Challenges of Types of Bus Service in Relation to Transit Oriented Development (cont.)

C. BUS RAPID TRANSIT (GOOD DESIGN)

Strengths and Challenges/Weaknesses

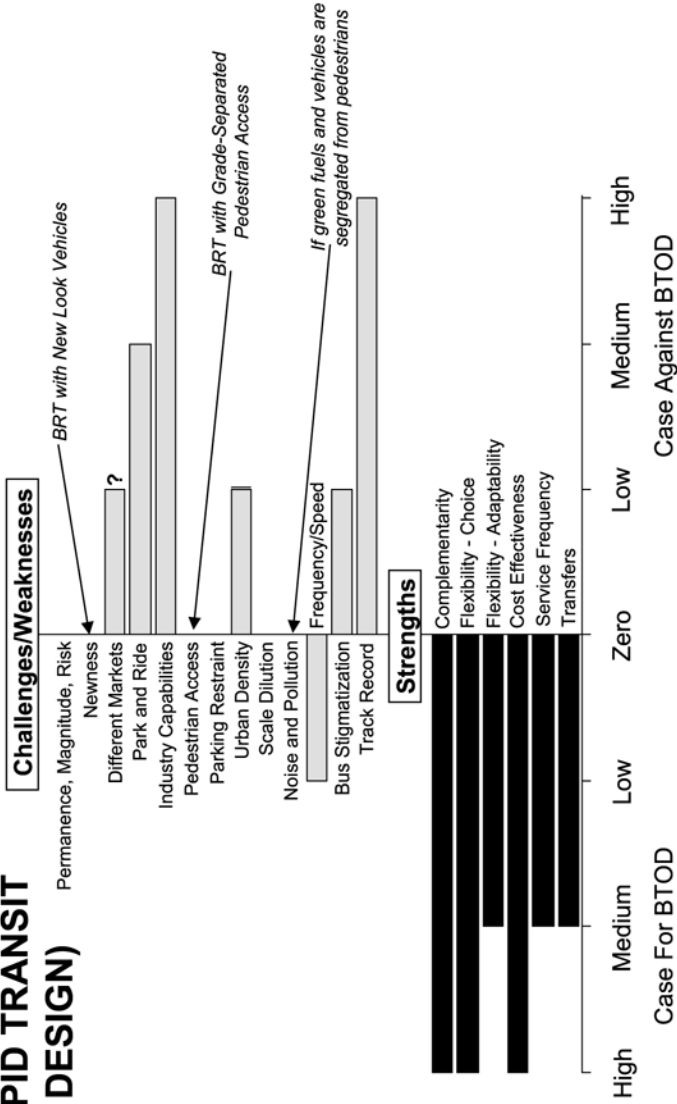


Figure 2 (A-C). Relative Strengths and Challenges of Types of Bus Service in Relation to Transit Oriented Development

BRT systems have a far stronger capability in relation to BTOD than local bus. However, the design of car access needs to be carefully balanced against the need for BTOD (as it does for rail). Bus noise and pollution issues are also valid concerns for BRT. The trend toward modern high-quality BRT vehicles is to be encouraged in systems seeking successful BTOD.

BTODs have a limited and unclear track record. There is a need to build knowledge and gain and share experiences to better develop, learn, and sell the potential benefits of BTOD to the community and the transit and urban development industry.

End Notes

¹ This article is an expanded version of a July 2005 conference presentation at the “Transit Oriented Development—Making It Happen” conference in Perth, Western Australia. See also Currie (2005b).

² A choice passenger is one who has access to a car but decides to use transit.

³ This is calculated based on Luscher’s relative RTOD and BTOD population sizes, the estimated reduction in VKMs identified, and the number of rail and bus TOD developments required for an average performance of TOD to reduce VKMs by 5 percent.

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