San Francisco's first BRT in Van Ness Avenue

CPLN 655 Multimodal Transportation Planning

Anran Zheng & Jing Zhang

In April 2022, San Francisco's first Bus Rapid Transit (BRT) service, operated by San Francisco Metro Transit Authority (SFMTA), was ultimately placed into operation along Van Ness Avenue after nearly 20-year planning and construction. It was an exciting service for the citizens and visitors initially, but the construction delays and budget overruns continually frustrated potential passengers and nearby businesses. The purpose of this case study is to introduce and evaluate the 20-year planning and implementation process of this BRT plan, as well as the corresponding decision-making and project management lessons learned for preventing future delays and overruns in transportation projects.

I. Background Information

1) Public Transportation System

San Francisco's transit network is backed by two famous transit systems: Bay Area Rapid Transit (BART) and San Francisco Municipal Railway (MUNI). BART operates 6 routes and 50 stations in five counties: Alameda, Contra Costa, San Francisco, San Mateo, and Santa Clara counties. Among the services, four routes run directly through San Francisco's downtown and office corridor, and serve a crucial role in connecting the city's residents and visitors with nearby communities (Figure1). MUNI primarily serves the city of San Francisco, and is the 8th busiest transit system in the country in terms of the ridership in 2019 (APTA, 2019). It operates 54 bus lines, 7 light rail lines, 17 trolley bus lines, and several historic streetcars lines, and carries more than 200 million passengers annually.

With regard to ridership by mode, Figure2 depicts how it has changed from 2018 to present, which demonstrates the importance of the bus network in the city. It shows that motor buses have been undertaking the city's majority of transit demands, and this has become increasingly prevalent since the outbreak of COVID-19: nearly 80% of riders used motor bus services during that time (SFMTA, 2022).

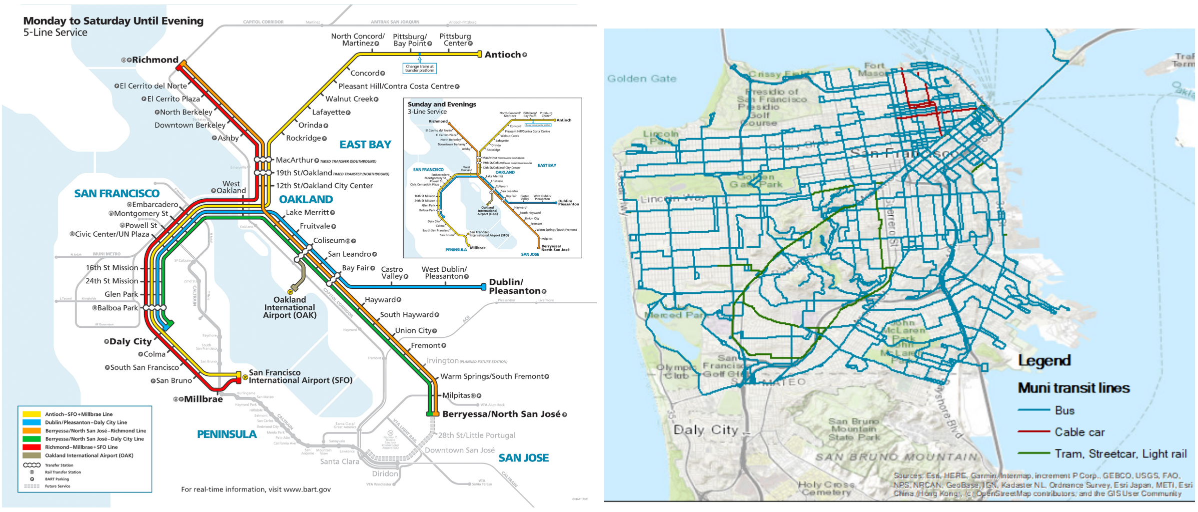

Figure1: BART System Map (left) and MUNI transit map (right)

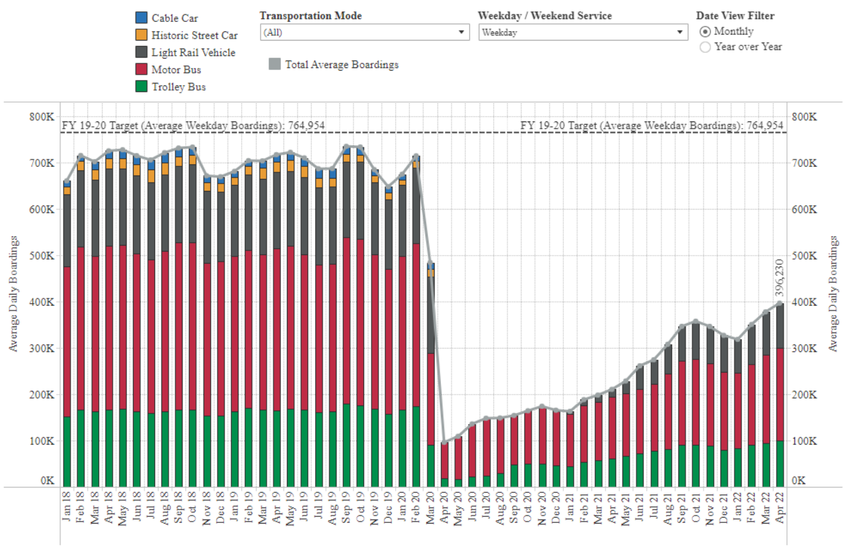

Figure2: Muni ridership, average weekday ridership (SFMTA, 2022)

2) The First Two BRT system

The city's BRT proposals get their start from Proposition K in 2003, where voters approved using half-a-cent of the sales tax to improve the city's bus and rail system. Then, as part of the New Expenditure Plan, the San Francisco County Transportation Authority (SFCTA) identified several critical transit projects based on present and future transit demand, including the first two BRT lanes. Figure3 visualizes the first two BRT corridor proposals: one is a north-south 2-mile long center-running BRT in Van Ness Avenue; another one is a 4.5-mile long side-running BRT in Geary Avenue, which connects the city's west and east ends. The two corridors were chosen because they were the busiest and had experienced the biggest passenger delays, which are predicted to continue into the future (SFCTA, 2006). However, the implementation process of the two corridors are completely different stories: the Van Ness Avenue BRT started construction in 2017 and was finally finished in 2022, whereas the first phase of Geary Avenue BRT began its construction in 2019 and was completed in 2021. For the following sections, the case study will zoom into Van Ness Avenue BRT's design and construction process to figure out what factors influenced the project's delivery.

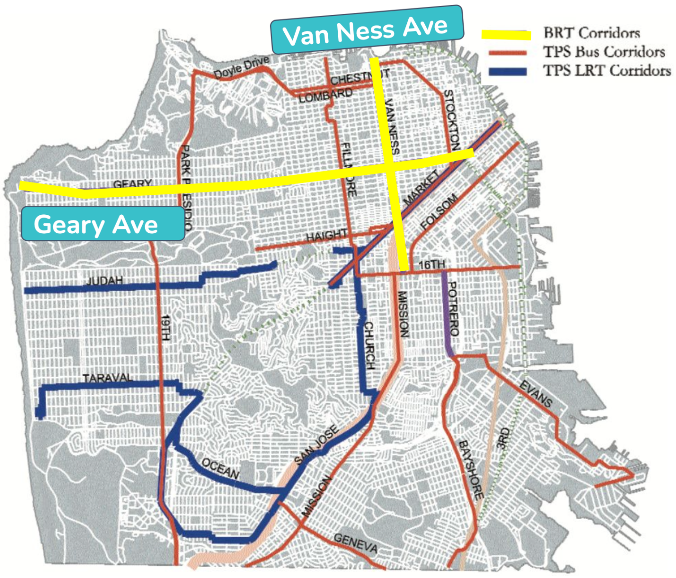

Figure3: New Expenditure Plan (SFCTA, 2006)

II. Design of Van Ness Avenue BRT

1) Overview

Locating in northeastern San Francisco and stretching from north to the south as Figure 4 shows, Van Ness Avenue serves as a major transit corridor and a part of U.S. 101 Highway. In a series of city planning and funding actions, Van Ness Avenue has been long identified as a high-priority transit improvement corridor. The Van Ness Avenue BRT project received environmental approval from SFMTA, Transportation Authority Board, and the Federal Transit Administration initially (SFCTA, 2022). Since then, SFMTA, SFDPW, PUC etc, became partners of project management and construction.

As one of the city's major streets, Van Ness Avenue serves a wide range of functions for the city. It provides nearly 45,000 job opportunities and 25,000 housing units, among most of them located in the old and walkable historic district. Since housing and workspace concentrated within easy walking distance, the improvement of Van Ness Avenue would affect thousands of passengers' transit experience, meanwhile, appealing to a great volume of new passengers into the new transportation system.

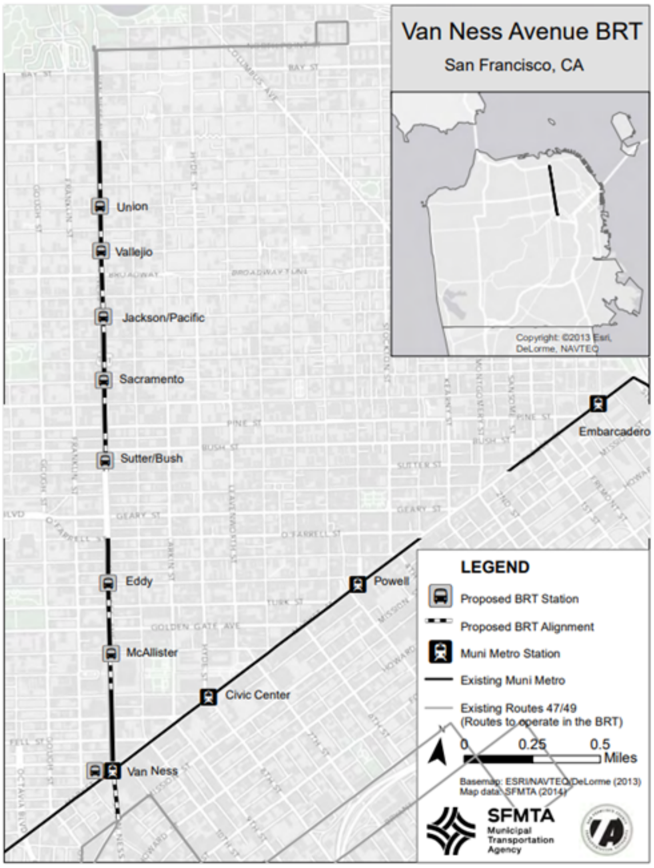

Figure 4. location of the project (Federal Transit Administration , 2014)

2) Previous transportation condition

As a major street in the transit road network, there is always high ridership and great travel demand on Van Ness Avenue. During the workday, Van Ness Avenue carries about 55, 000 trips in total as Table 1 shows. On a daily average, about 39, 000 people drive by private vehicle on Van Ness Avenue, which accounts for 31% of the total vehicles traveling on the corridor. In addition, about 16, 000 daily passengers travel through transit at Van Ness Avenue, which accounts for 80% of the total transit trip in the corridor. Among all the routes operating along the Van Ness Avenue, Route 47 and 49 are two principal transit routes. Approximately every day 43, 000 passengers travel with route 47 and 49, while other routes carry about 16, 000 daily passengers.

	PRIVATE VEHICLE	TRANSIT	TOTAL
Van Ness Avenue	39,000 (71%)	16,000 (29%)	55,000 (100%)
Van Ness Avenue Corridor Study Area	126,000 (86%)	20,000 (14%)	146,000 (100%)

Note: The Van Ness Avenue corridor study area is defined as Van Ness Avenue and five parallel streets, including Gough and Franklin streets to the west and Polk, Larkin, and Hyde streets to the east. Screenlines were defined as motorized traffic that crossed specific streets up and down the corridor, specifically Fell, McAllister, Geary, California, Broadway, and Lombard.

Source: SF-CHAMP

Table 1. weekday travel demand on Van Ness Avenue v.s. Van Ness Avenue Corridor Study Area (SFCTA, 2013)

The large volume of travel demand on Van Ness Avenue would easily lead to the challenge of traffic congestion. The bus travels only at 8 mph on average, which leads to about 8-minute travel time delay during peak hours. Moreover, the signal visibility was poor on Van Ness Avenue and would cause signal delay. According to figure 2, the mixed traffic delay and signal delay accounts for 66% of total delay.

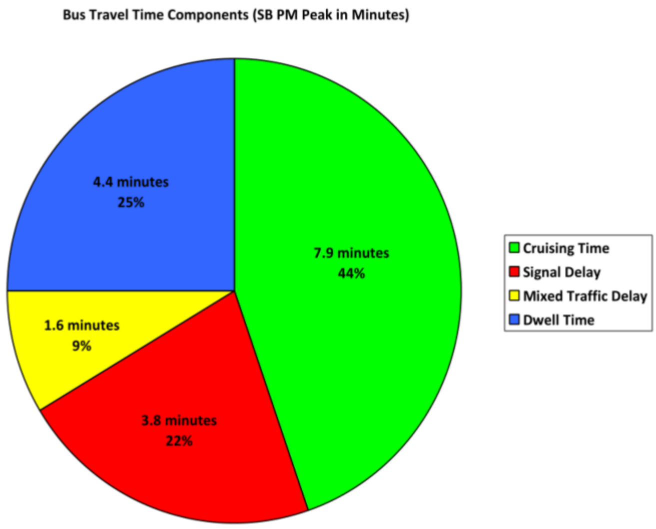

Figure 5. component of transit travel time on Van Ness Avenue during peak hour (SFCTA, 2013)

Aside from traffic congestion and time delay, safety is another major challenge before the introduction of Van Ness Avenue BRT. During the year 2003 to 2008, almost 97% of vehicle collisions happened on the crossing of Van Ness Avenue. The most common vehicle collision type is broadside, which accounts for 41% and happens especially when turning left *(SFCTA, 2013)*. Approximately 30% of traffic incidents happen due to sudden parking and poor invisibility of traffic signals. Even fine zone was set up in study area from 2008 to 2010, the pedestrian collision incidents still increase at Van Ness Avenue.

3) Goals

The intent of Van Ness Avenue BRT project is to promote the development of the city and meet the transportation system performance needs. Based on the above transit challenges, Van Ness Avenue BRT is introduced to fulfill the following purposes:

1. Improve the transit efficiency, reliability, and connectivity
   The time delay of buses suggests the low efficiency and connectivity of Van Ness Avenue. With BRT, transit travel time, reliability and boarding will enhance up to 32%, 50% and 35% respectively. In detail, there are two ways to satisfy the transit performance needs. First, as currently the auto and bus utilize the same lane, they should be separated to save the travel time and enhance the service

reliability. Second, reduce the delays regarding the traffic signals and loading or unloading since this would cause unnecessary delays.

2. Improve pedestrian safety, comfort, and convenience
   Along the Van Ness Avenue, about 46% of communities don't own vehicles, which is higher than the percentage of no car ownership families throughout the whole San Francisco (29%). Around 26% of people choose walking as the commuting pattern in Van Ness Avenue Neighborhood, which exceeds the citywide average of 17%. Therefore, walking and cycling become important traveling patterns in Van Ness Avenue. BRT can improve pedestrian visibility by providing curb extension and narrowing the distance of crossings, which can highly improve the safety and convenience of pedestrians.
3. Enhance urban design and beautify the environment
   Existing streetscape lacks the street connection and walking infrastructure. One important part of BRT project is to provide the lighting, street furniture, greenspace, and improved streetscape. The enhanced urban design would reinforce the identity of Van Ness Avenue as a high-priority transit improvement in local transportation planning.

4) Project Features and Alternatives

BRT Features

According to Figure 6, BRT on Van Ness Avenue would include the following features:

1. transit-only lanes which are physically separated from the auto lanes
2. optimized traffic signals for the bus
3. low-floor vehicles and all-door boarding
4. improvement for pedestrian safety
5. fully furnished boarding platform, including shelter, seats, and monitors

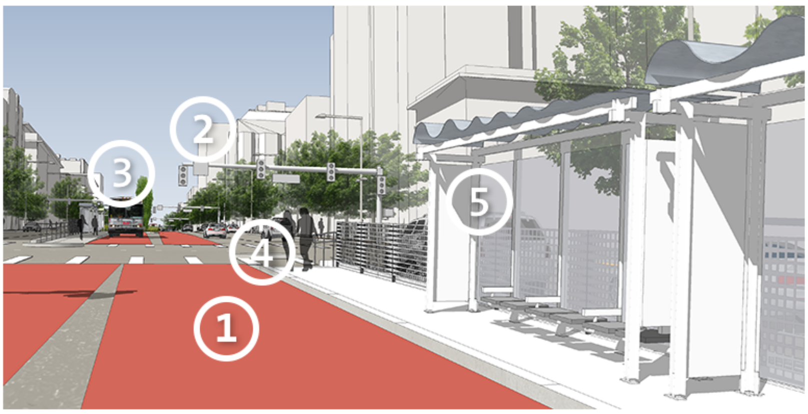

Figure 6. typical BRT features (Caltrans, 2020)

Among all these important BRT features, two types of designed features are highly promoted in Van Ness Avenue BRT project: the low boarding platform and platform configuration. According to Figure 7, low boarding platform can assist passengers in wheelchairs from the front door and promote the consistency between BRT and the stops. This would satisfy the goal of building transit reliability and flexibility, saving time and minimizing cost.

Figure 7. examples of low boarding platform (Source: Google)

Another significant designed feature is platform configuration, among which SFMTA Standard Shelter is a good example. Shelters would provide pedestrians convenience and safety when waiting for BRT, especially under harsh weather conditions. Like low boarding platforms, shelters could also minimize maintenance and construction costs.

In any BRT design on Van Ness, the above features would be combined and presented in different placements of transit lanes, station platforms, and landscape medians (Eric, 2008). Four potential designs were proposed and compared. No built alternative is the first design, which refuses to build BRT and brings no change to the existing conditions. Therefore, the other three alternatives will be studied and compared below.

Alternative 2: Side BRT Lanes

As Figure 8 shows, alternative 2 would build the dedicated bus lanes on the right-most lane of Van Ness Avenue, which allows mixed-flow traffic that would enter the transit lane to turn right. BRT stops would locate on the curbside parking region as parking extensions.

Even though the construction cost and impact of alternative 2 is the least, it brings the least transit benefits as well. It could only save about 24% of transit time, while alternative 3 and 4 could save up to 30%. In detail, from the Mission St to the Lombard St, alternative 2 could only save the original 19.4 minutes of bus traveling time to 14.9 minutes. In contrast, alternative 3 and 4 could save to 13.5 minutes. Besides, alternative 2 causes very little impact on the travel time of auto. If center BRT is applied as alternative 3&4, the travel time of autos would increase from 11.2 minutes to 11.5 minutes according to Figure 9.

Figure 8. alternative 2: side-running bus lanes (Bialick, 2011)

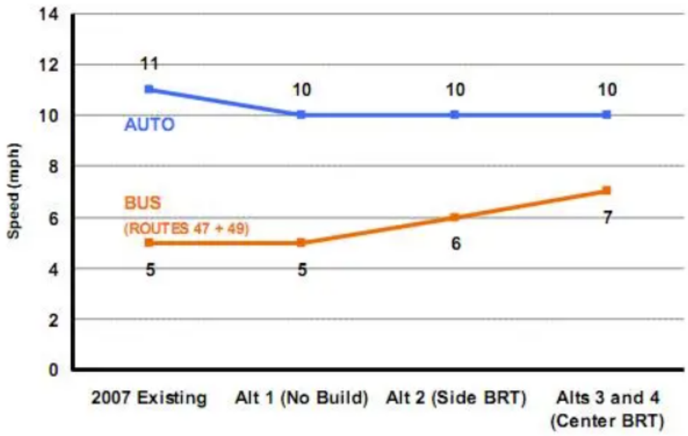

Figure 9. comparison of bus and auto speeds for each of the projects' alternative (Bialick, 2011)

Alternative 3: Center BRT Lanes with Right Side Loading / Dual Medians

Alternative 3 would provide two side-by-side dedicated bus lanes between two medians. The bus lane would be separated from the mixed-transit flow with a 4-foot wide median, which would be widened to 9 inch and allow passengers to board on the right side.

Vehicle collision and time delay risks exist in alternative 3 when one bus will exceed the other. The dedicated bus lane is easily occupied by other types of cars, which becomes a common problem at Mission, Geary and O'Farrell Streets. On such bus lanes, drivers usually stop, turn right and park their cars because dedicated bus lanes are placed together with parking zones. Consequently, transit will delay as buses traverse on other lanes. This plan also has the most operating cost, since it needs more investment in maintaining bus lanes and greenspace. Besides, it also requires the highest number of median trees removed.

Figure 10. alternative 3: a center-running busway between two medians (Bialick, 2011)

Alternative 4: Center BRT Lanes with Left Side Loading / Center Median

Alternative 4 would provide a transitway at central road, from which the other two sides are northbound and southbound bus lanes respectively. Station platforms located in the median, which requires passengers to board on the left and bus has left-side doors. This might limit Muni's flexibility because bus needs to have doors on both sides.

Figure 11. Alternative 4: center running bus lanes on the outside of a single median (Bialick, 2011)

Based on alternative 3 and 4, which both promote the center running bus lanes, design option B was then proposed. This design option would eliminate all but one northbound turn at Lombard Street, which would have nearly twice the travel time savings and reliability benefits as side BRT lanes proposed in alternative 2.

Summary and comparison of proposed alternatives

Alternatives	#2	#3	#4
Description	Side BRT Lanes	Center BRT Lanes with Right Side Loading / Dual Medians	Center BRT Lanes with Left Side Loading / Center Median
Time savings (min)	17.5 → 14.3 (bus) 8.8 → 9.4 (auto)	17.5 → 12.9 (bus) 8.8 → 8.6 (bus)	
Average delay for all intersection (min)	12	13	11
Transit trip %	40	44	
Daily boarding	49100 (+29%)	52300(+37%)	
Cost (million $)	93	136	112
Tree removal	20 (median) + 38 (sidewalk)	102	64
Benefits	Least cost	Significant time savings	
Shortcomings	Least time savings	Most expensive Removal of most trees Risk of car crashes	Limit Muni's flexibility Procurement risk

Table 2. comparison of BRT design alternatives (SF-CHAMP, 2022)

Table 2 summarized the impact, advantages and shortcomings of the three BRT design alternatives introduced before. As the BRT project develops, transit ridership would increase on the 47 and 49 route so as to the entire transit system because all of the BRT alternatives are expected to divert traffic flow from Van Ness Avenue to other corridors and somewhere in the city. Alternative 2 would bring almost no impact on the traffic congestion, while alternative 3 and 4 would not bring major impact on the traffic congestion until the year 2035. The advantages of center running BRT outweighs the side running BRT due to the time savings, enhanced ridership, and reliability.

5) Final Implementation

Based on the technical analysis and public feedback, a locally preferred alternative, also called LPA, was finally selected. LPA is a combination and refinement of alternative 3 and 4, which allows Center-Running BRT with Right Side Loading/Center Median and Limited Left Turns. LPA not only retains the high-performance features of alternative 3 and 4, such as the maximum transit priority and least conflicts but also avoids the necessity of bus with left-side doors or removal of the entire central zone. It also incorporates design option B, which eliminates the need of turning left at Mission or Lombard St. In this way, the transit travel time benefits would be maximized, and the flow of north-south traffic flow would be aided along the Van Ness Avenue.

Compared with the previously proposed design alternatives, LPA has the following benefits. It brings shorter travel time, together with better reliability and ridership. Specifically, LPA will reduce up to 33% of travel time and narrow the difference between travel time of vehicle and transit down to 50%. The unexpected delay likelihood of buses would reduce 52%. In addition, LPA contributes to a better streetscape with more trees as table 3 shows, which causes the least removal of trees.

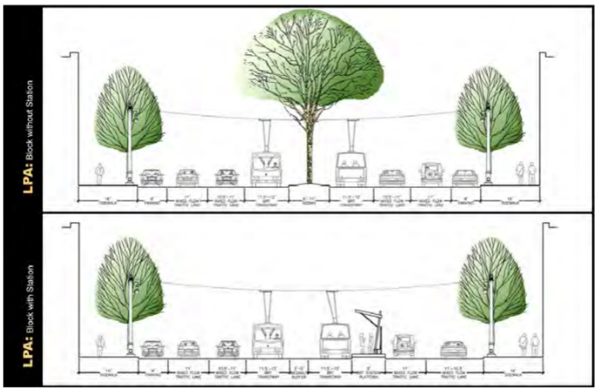

Figure 12. final implementation of LPA: Center-Running BRT with Right-Side Loading/Single Median and Limited Left Turns (SFCTA, 2013)

	Median Trees Removed	Sidewalk Trees Removed	New Median Trees	New Sidewalk Trees	Net Total Trees
Alt 2	20	38	103	68	529
Alt 3	102	0	163	48	525
Alt 4	64	0	113	48	513
LPA	80	0	85	48	469

Table 3. tree analysis between proposed alternatives above and LPA (SFMTA, 2012)

6) Financial Structure

The total cost of the project was anticipated to be $309 million, with more than half of it spent on transit-related work. Table4 summarizes the financial sources for transit construction, showing that a federal grant funded half of the project: 27% of the funding came from by the Federal Transit Administration (FTA)'s Capital Investment Grant (CIG) program, which is a discretionary grant aimed at supporting the construction or expansion of fixed-guideway transit systems (FTA, n.d.); and 18% granted from FTA's Bus and Bus Facilities program which is a formula allocated and competitive grants (FTA, n.d.). The remaining came from the local government, for example the half-of-cent sales tax, SFMTA issued revenue bonds, and impact fee. The impact fee was collected from California Pacific Medical Center because the increased employees over there will potentially burden the transit services (San Francisco Planning, n.d.).

	Funding Sources	Fund (million)	Share (Total)	Share
Federal	FTA's CIG program	$45	46.00%	27.60%
	FTA's Bus and Bus Facilities program	$30		18.40%
State	State Highway Operation and Protection Program	$7.31	4.50%	4.50%
Local	Proposition K Sales Tax	$36.3	49.50%	22.30%
	SFMTA Revenue Bonds and Operating Funds	$26.35		16.20%
	Central Freeway Parcel Revenues	$12.66		7.80%
	Development Impact Fees (California Pacific Medical Center)	$5		3.10%
	SFCTA Planning, Programming and Monitoring Funds	$0.2		0.10%
Total		$162.82		100%

Table 4: Financial structure of Van Ness Avenue BRT transit-related cost (money in 2014) (FTA, 2014)

III. Analysis of the Project

1) WHY Delay

In 2013, the final Environmental Impact Review (EIR) for the 2-mile BRT was approved after nearly 13 years of researching and designing starting from 2003. However, when stepping into the implementation process, the project encountered several unanticipated issues which caused the service to be delayed for over three years. After 6 years of negotiation and construction, it was ultimately completed in April 2022. The Figure13 summarizes the key implementation timeline. The SFMTA's inability to complete projects on time has damaged the public's confidence in the agency. Additionally, residents and businesses along this corridor as well as the drivers and pedestrians were adversely affected by the ongoing construction.

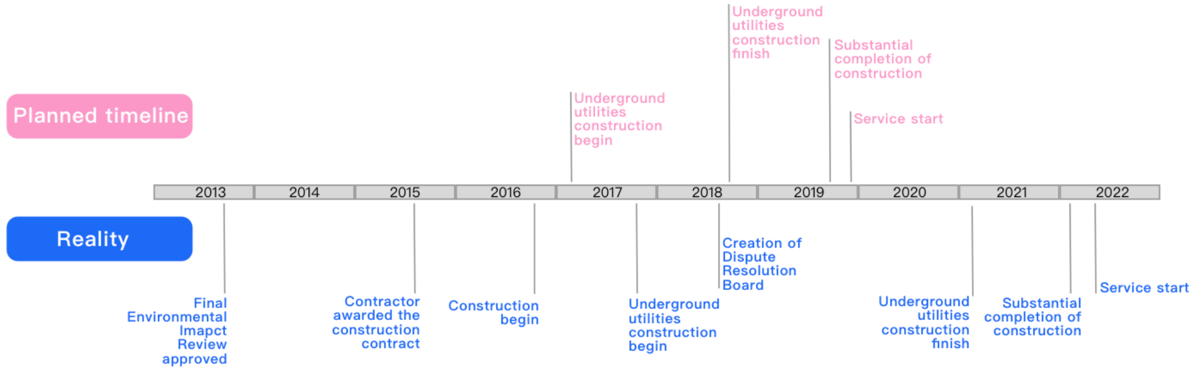

Figure 13: Implementation Timeline summary

Delay reason 1 - Lack of knowledge of the utility

The biggest issue causing the delay and budget overruns is the city's failure to adequately evaluate underground infrastructure and its lack of knowledge of the location of underground outdated sewer lines and water lines. The contractor, Walsh, broke ground at the outset of the construction, and discovered that the utility maps were mostly inaccurate, and afterward, the team just found out the 100-year-old utility line runs directly beneath the center-running BRT design. Although the uncertain utility line was identified as one of the potential risks by the engineering team, it was not given enough attention during the design phase or considered as one of the metrics when comparing different alternatives.

Actually, the location of the outdated utility makes center-running BRT design a challenge and needs to be immediately relocated. Firstly, in the event of any further repairment to the utility, the BRT services would be suspended; secondly, for the safety of the maintainer, the overhead contact system needs to be temporarily de-energized to comply with the 20-foot overhead clearance regulation when working close to a power line (US Dept. of Labor, n.d.). The relocation of the sewer lines and water lines will certainly delay the delivery of services, whereas the side-running lane won't have these problems and can ensure the delivery to a certain extent. While SFMTA weighs the long-term benefits of the center-running design: it’s more efficient due to the few interactions with right-turning vehicles and it provides a better pedestrian experience because of the middle island as above mentioned. Therefore, in spite of the additional construction time and cost, the SFMTA decided to allocate the central water and sewer lines as Figure 14 shows.

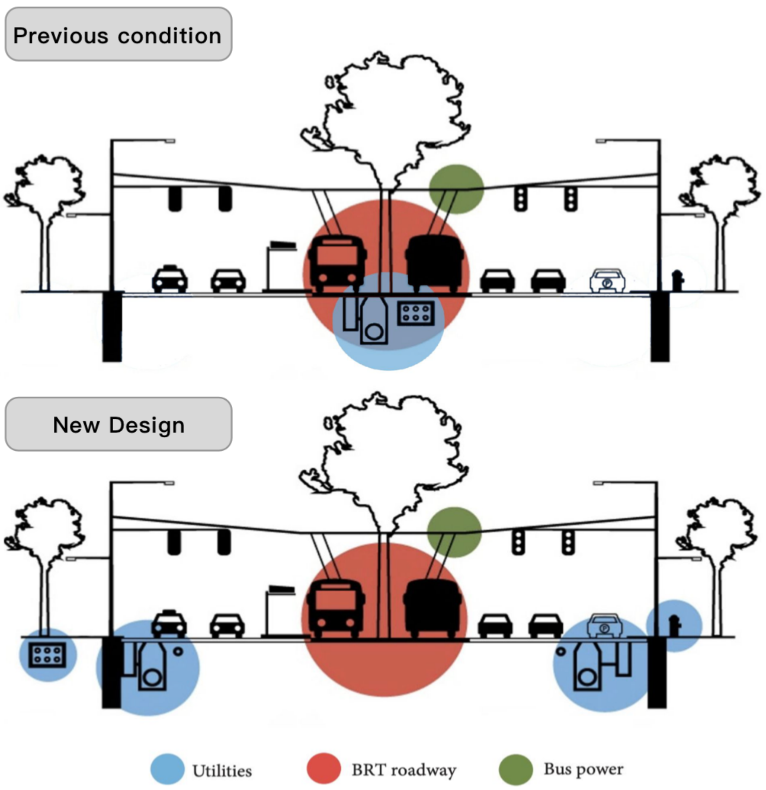

Figure 14: illustration of the location of BRT and utilities (City and County of San Francisco Civil Grand Jury (SFCGJ), 2021)

There are many methods to avoid this mistake in advance thereby allowing for a more accurate estimate of the construction schedule and cost. Potholing and ground-penetrating radars, for instance, are ways of verifying utility information prior to construction; unfortunately, much of the assessment in this project was implemented after construction began and caused the delay.

Delay reason 2 - Project management

The second issue causing the delay is more related to project management. Early in 2014, the project decided to adopt the Construction Manager/General constructor delivery model (CMGC). Unlike traditional delivery models, such as Design-Build and Design-Bid-Build, this model brings contractors and designers to the team almost at the same time as Figure 15 illustrated. It allows the three stakeholders (contractor, designer, and project owner) with different standpoints to work together. With considerable communication and collaboration, the team is able to produce a design that meets the budget and guarantees the general quality. For this method, the project owner needs to make the contract with the designer and contractor separately and the project owner (SFMTA) needs to facilitate and make the final decision for every step, which is like the role of the project manager (Perlo, 2020). However, this is the first time the city tried to apply the CMGC model in the transportation domain (SFCGJ, 2021), they made a few mistakes and were unable to take full advantage of the model, therefore making the project delayed again.

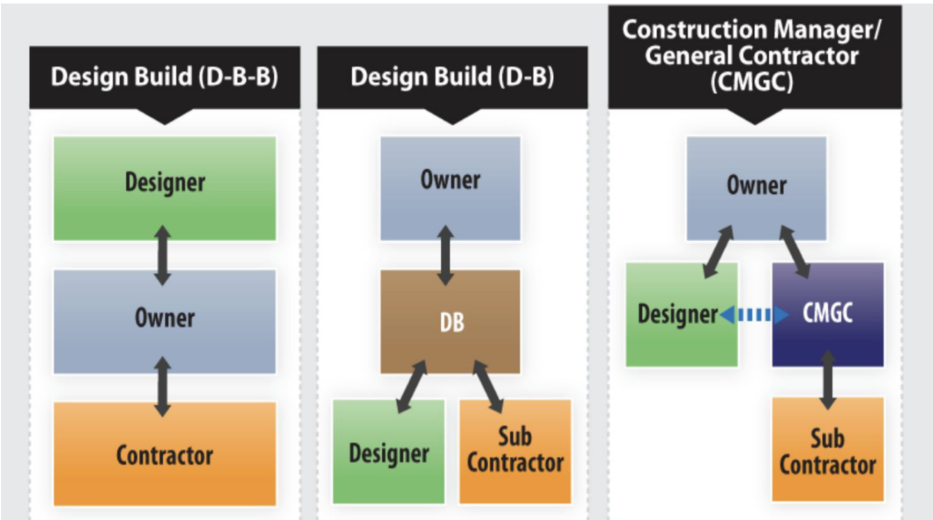

Figure 15: Comparison between different delivery models (Colorado Dept. of Transportation, 2015)

By bringing three different parties together, CMGC can take into account different viewpoints and come up with a more comprehensive plan. However, the SFMTA board involved two key stakeholders too late for this project, which caused subsequent issues. First is the contractor, Walsh, was brought on when 70% of the design had already been completed, so they didn't have enough time to participate in the designing process and identify risks from their professional standpoint. Best practices in the industry recommend contractors should be involved as early as possible, no later than 30% of the design has been completed (SFCGJ, 2021).

Apart from that, the owner of the utility, the San Francisco Public Utilities Commission (SFPUC) did not participate sufficiently in the contracting phases, even though they shared the cost with the SFMTA. Initially, SFPUC was not involved enough in the subcontractor contracting process. Therefore, when Walsh signed the subcontract with a $20 million agreement, SFPUC indicated their estimate is only approximately $16 million, so the contractor was forced to withdraw the original subcontractor and rebid. It took about 8 months for the project to be rebid. Unfortunately, there was only one subcontractor for this round and they offered $30 million (SFCGJ, 2021), which is much higher than the previous one. However, Walsh has no alternative, the project cannot be further delayed. The rebidment almost eliminates the contractor's profit from this project and dampens their excitement.

Thereafter, the relationship between the contractor and the city deteriorates, and they lose trust in each other. The shrinking profits made Walsh reluctant to take risks, so they couldn't reach a consensus on many technical details and even set up a formal dispute resolution board to get a third party involved, which clearly slowed down the decision-making process.

2) Is Center-running the best option?

Undoubtedly, lack of knowledge of underground utility as well as the inexperienced project management are the main issues causing the severe delay and budget overrun of the project. However, the story of Geary Avenue BRT, another BRT corridor in the city, casts doubt on Van Ness Avenue BRT's persistence in the center-running lane over the side-running one. Geary Ave BRT is a two-phase project as shown in Figure 16, the first phase was planned as a side-running BRT between Stanyan Street and Market Street considering the street configuration over this section is not suitable for more efficient center-running BRT lanes (SFMTA, n.d.). It was opened around Fall 2021. The second phase, from Arguello Blvd to 28th Ave, was initially envisioned as a center-running BRT. However, because of the COVID, the second phase was paused and replaced by a temporary side-running Transit Only Lane. As traffic bounced back to the city, SFMTA found the bus speed on the temporary side-running lane kept consistent or even better. The side-running proposal is also supported by more than 60% of survey respondents, as it reduces construction disruption and costs (SFCTA, 2022). Therefore, SFMTA decided to drop the original plan and pivoted to focus on transferring the temporary side-running lane to permanent one.

Figure 16: Illustration of two-phases Geary Avenue BRT

BRT that runs in the center is the most common configuration around the world because it eliminates the conflict with turning traffic, stopping traffic (parking & taxis), and other non-motorized traffic. It can substantially increase travel efficiency compared to side-running proposals (ITDP, n.d.). However, in the case of Van Ness Ave BRT, considering this is only a 2-mile long BRT service, its help in time-saving is actually limited. As Table2 summarized, the center-running configuration only saves 1.4 minutes more compared with side-running one while spending more than $32 million and longer construction time, not including the time and monetary cost of relocation of underground utilities.

Further, saving the investment by adopting the side-running configuration in Van Ness Avenue and using it in extending the BRT service to the rest of the city might increase the whole city's travel efficiency and serve more riders. Comparing the severe delay corridor in the 2020 Winter (Figure 17) and the future transit-only lanes planning, (Figure 18) several corridors with considerable bus riders still suffered from the severe delay.

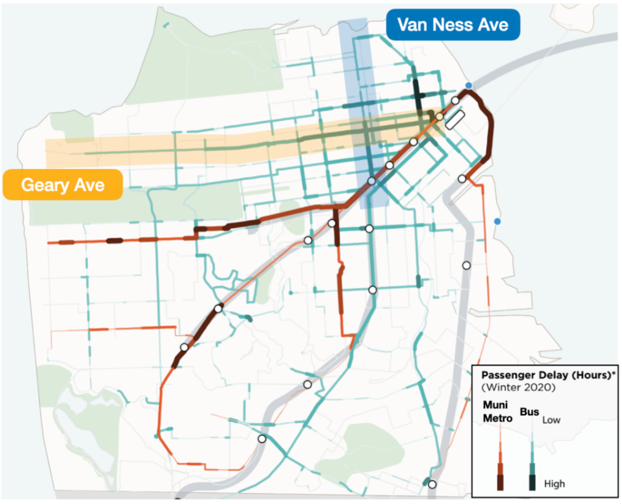

Figure 17: Passenger delay (Hours) in San Francisco (SFMTA & SFCTA, 2021) (left)
Figure 18: Transit Lanes in San Francisco (Rhodes, 2021) (right)

IV. Conclusion

This case study reviewed the Van Ness Avenue BRT's design and construction process, highlighting the main causes of the project's delay and cost overrun are the project owner's lack of attention to the underground facility and the inexperienced project management. After evaluating the actual time and financial costs of this center-running BRT services, as well as the foreseeable benefits on travel efficiency, this report questions whether side-running BRT would be a more cost-effective alternative for this corridor. Nevertheless, the center-running service was operated in April 2022. The long-term benefits that this center-running BRT might bring to Van Ness Avenue, such as enhancing transit efficiency and improving pedestrian safety, have yet to be fully verified.

V. Reference

[1] American Public Transportation Association (APTA). (2019). 2019 PUBLIC TRANSPORTATION FACT BOOK. Retrieved May 4, 2022, from https://www.apta.com/wp-content/uploads/APTA_Fact-Book-2019_FINAL.pdf

[2] San Francisco Municipal Transportation Agency (SFMTA). (2022). Muni ridership: average weekday ridership. Retrieved May 5, 2022, from https://www.sfmta.com/reports/muni-ridership-average-weekday-ridership

[3] San Francisco County Transportation Authority (SFCTA). (2006). VAN NESS AVENUE BUS RAPID TRANSIT (BRT) FEASIBILITY STUDY. Retrieved May 4, 2022, from https://www.sfcta.org/sites/default/files/2019-02/Van%20Ness%20BRTFeasibilityStudy_Dec_2006.pdf

[4] SFCTA. (2013).Van Ness Avenue Bus Rapid Transit Project. Final Environmental Impact Statement/Environmental Impact Report. https://www.sfcta.org/sites/default/files/2019-02/Van_Ness_BRT_Final_EIS_EIR_Volume_I.pdf

[5] SFCTA. Van Ness Improvement Project. Retrieved May 4, 2022, from https://www.sfcta.org/projects/van-ness-improvement-project

[6] Caltrans (2020, September 11). Traffic changes on Van Ness begin September 14. Caltrans. Retrieved May 6, 2022, from https://dot.ca.gov/caltrans-near-me/district-4/d4-news/2020-09-11-traffic-changes-on-van-ness-begin-september-14

[7] Eric (2008, January 19). Van Ness BRT: Design alternatives. Transbay Blog. Retrieved May 6, 2022, from https://transbayblog.com/2007/10/08/van-ness-brt-design-alternatives/

[8] Bialick, A. (2012, February 2). What's the best design for Van Ness BRT? Streetsblog San Francisco. Retrieved May 6, 2022, from https://sf.streetsblog.org/2011/12/01/whats-the-best-design-for-van-ness-brt/

[9] Urban Forestry Council & SFMTA (2012, December 14). Van Ness Avenue Bus Rapid Transit (BRT). Retrieved May 9, 2022, from https://sfenvironment.org/sites/default/files/agenda/attach/urbanforestrycouncil_van_ness_brt_121412.pdf

[10] Federal Transit Administration (FTA). (2014). Van Ness Avenue BRT San Francisco, California Small Starts Project Development. Retrieved May 9, 2022, from https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/CA__San_Francisco_Van_Ness_Avenue_BRT_Profile_FY16.pdf

[11] FTA. (n.d.). Capital Investment Grants Program New Starts, Small Starts and Core Capacity Improvements. Retrieved May 9, 2022, from https://www.transit.dot.gov/CIG

[12] FTA. (n.d.). Grants for Buses and Bus Facilities Program. Retrieved May 5, 2022, from https://www.transit.dot.gov/bus-program
[13] San Francisco Planning. (n.d.). California Pacific Medical Center (CPMC). Retrieved May 5, 2022, from https://sfplanning.org/california-pacific-medical-center-cpmc
[14] US Department of Labor. (n.d.). Occupational Safety and Health Administration. Retrieved May 5, 2022, from https://www.osha.gov/laws-regs/regulations/standardnumber/1926/1926.1408
[15] City and County of San Francisco Civil Grand Jury (SFCGJ). (2021). Van Ness Avenue: What Lies Beneath. Retrieved May 5, 2022, from https://civilgrandjury.sfgov.org/2020_2021/2021%20CGJ%20Report_Van%20Ness%20Avenue%20-%20What%20Lies%20Beneath.pdf
[16] Perlo Construction. (2020). Construction Project Delivery Types. Retrieved May 4, 2022, from https://perlo.biz/construction-project-delivery-types/
[17] Colorado Dept. of Transportation. (2015). (CMGC) Construction Manager/General Contractor. Retrieved May 4, 2022, from https://www.codot.gov/business/alternativedelivery/assets/cmgc-manual.pdf
[18] SFMTA. (n.d.). Geary Boulevard Improvement Project. Retrieved May 4, 2022, from https://storymaps.arcgis.com/stories/01f13029bfa64f8892c279311ef6b644
[19] SFMTA (2022). Geary Boulevard Improvement Project Outreach Round 1 Survey Results. Retrieved May 4, 2022, from https://www.sfmta.com/sites/default/files/reports-and-documents/2022/01/geary_boulevard_improvement_project_survey_r1_results.pdf
[20] ITDP. (n.d). BRT Planning Guide-22.2 Roadway Configurations. Retrieved May 4, 2022, from https://brtguide.itdp.org/branch/master/guide/roadway-and-station-configurations/roadway-configurations
[21] SFMTA & SFCTA. (2021). Connect SF Transit Strategy. Retrieved May 4, 2022, from https://connectsf.org/wp-content/uploads/ConnectSF_Transit_Strategy_FINAL-20211209-1.pdf
[22] Rhodes, M. (2021). Animated Map Shows Record Expansion of Transit Lanes. Retrieved May 4, 2022, from https://www.sfmta.com/blog/animated-map-shows-record-expansion-transit-lanes