The Strengths of Using Multiple Audit Methodologies
Case Study of Washington State Ferries
Vessel Construction Program

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Why we audited WSF's Vessel Construction Program

What we did

Our audit questions:

- How do construction costs for WSF's vessels compare to other purchasers?
- What factors affect construction cost and total construction spending?
- Does WSF follow leading practices to design and construct its ferries?

What we found

- It costs more to build a ferry when WSF is the purchaser.
- Two regulatory requirements limit competition and increase construction costs.
  - Build in Washington laws
  - Apprenticeship Act requirements
- Vessel construction costs could be reduced through better use of leading practices.

Data collection methods

- Identified all US-built ferries through a review of national databases complied by US Army Corps of Engineers and the US Department of Transportation
- Selected ferry purchasers for our audit based on three criteria:
  - They had purchased a ferry since 1991
  - Had built at least one ferry over 100 gross tons
  - Had built a ferry in Washington state
- Eight ferry purchasers were included in our analysis.

Ferry purchasers we visited

These purchasers provided data on the 39 ferries in our analysis.

Alaska Marine Highway System	Staten Island Ferries
North Carolina Department of Transportation	Texas Department of Transportation
Pierce County Public Works and Utilities	Woods Hole, Martha's Vineyard & Nantucket Steamship Authority
San Francisco Water Emergency Transportation Authority	Washington State Ferries

We also visited British Columbia Ferry Services (BC Ferries). While they shared information on their new ferry construction program, we did not include their vessels in our analysis.

WSF Vessels included in our analysis

Class – Passenger/vehicle capacity	Vessel name, year built
Jumbo Mark II – 2,500 / 202	*Tacoma, 1997*
	Wenatchee, 1998
	Puyallup, 1999
Kwa-di Tabil – 750 / 64	*Chetzemoka, 2010*
	Salish, 2011
	Kennewick, 2012

Data collection at ferry purchasers

- We developed and used a structured interview tool to collection information at each of the eight purchasers we visited related to each of our audit questions:
  - Cost and descriptive information for ferries they purchased since 1991
  - What factors they believe impact ferry construction cost
  - Rules and regulations that govern how they design and purchase their ferries
  - Practices used to design and construct their ferries, including those they view as effective

Methods used to address audit questions

<table>
<tr><th>Audit questions</th><th colspan="3">Methods</th></tr>
<tr><td>How do construction costs for WSF's vessels compare to other purchasers?</td><td rowspan="2">Statistical analysis</td><td rowspan="3">Case studies</td><td rowspan="3">Expert panel</td></tr>
<tr><td>What factors affect construction costs?</td></tr>
<tr><td>Does WSF follow leading practices to design and construct its ferries?</td><td>Gap analysis to assess WSF use of leading practices</td></tr>
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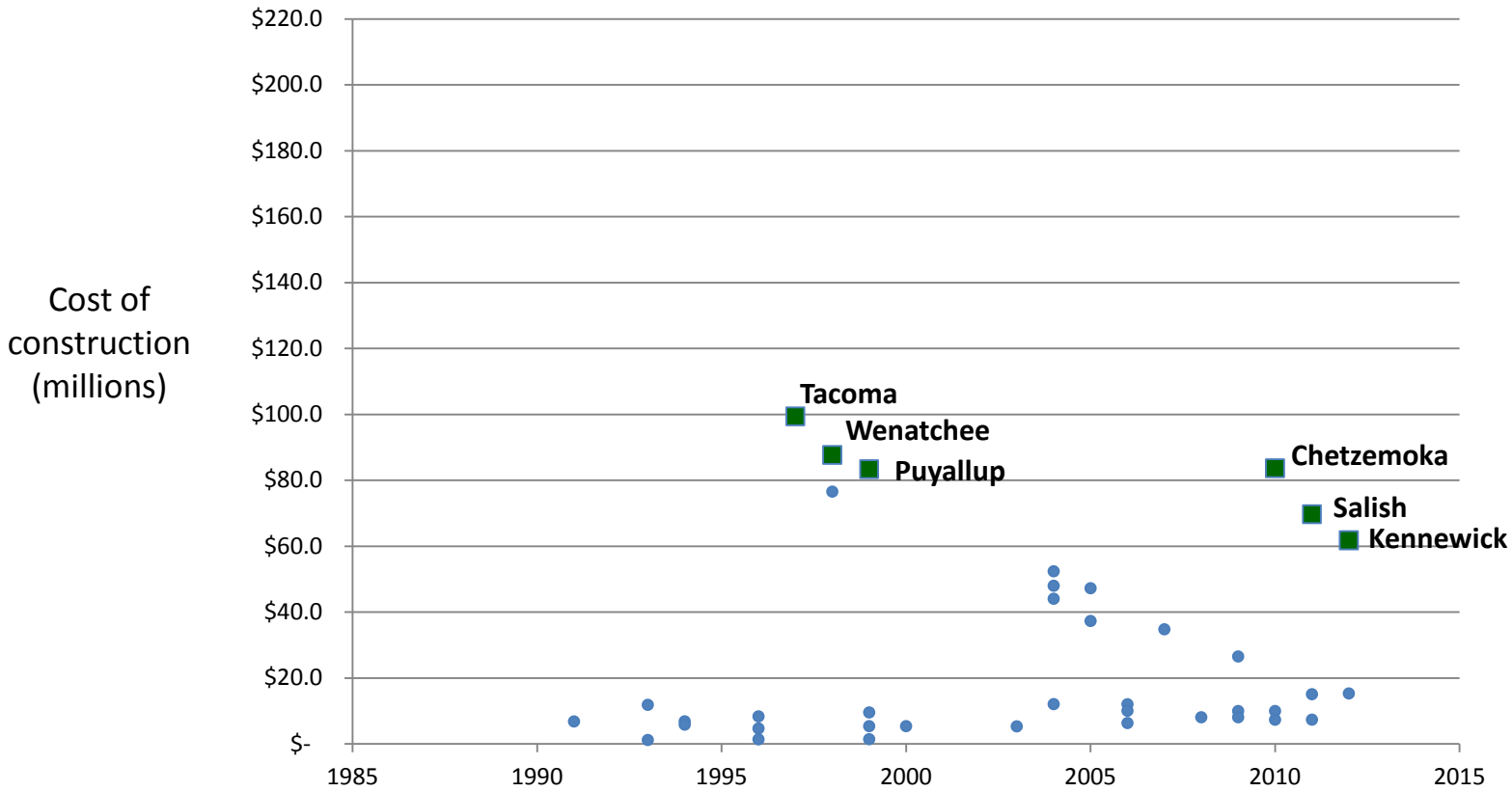
How do the cost of WSF ferries compare?

Washington ferries are among the most expensive built in last 20 years



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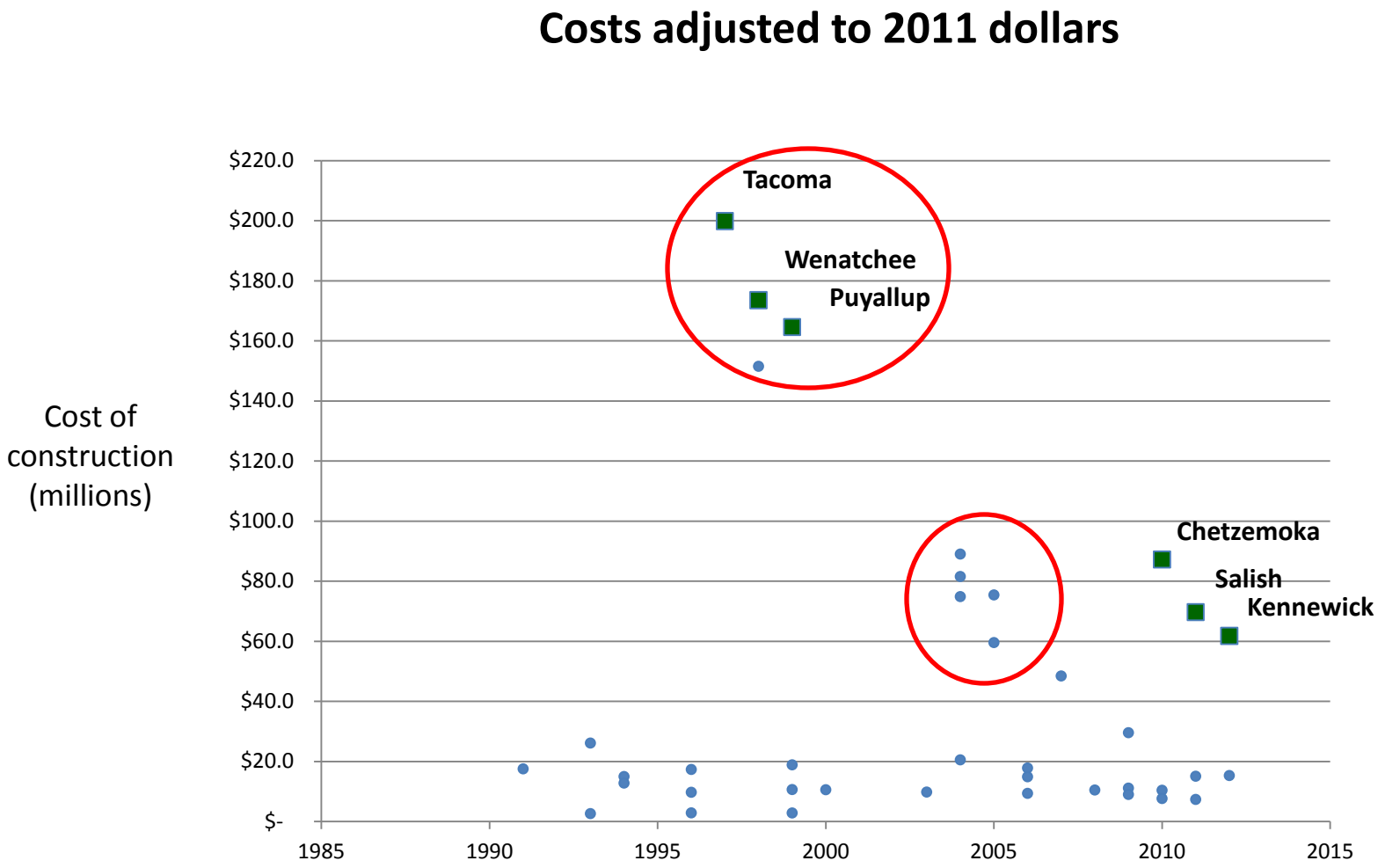

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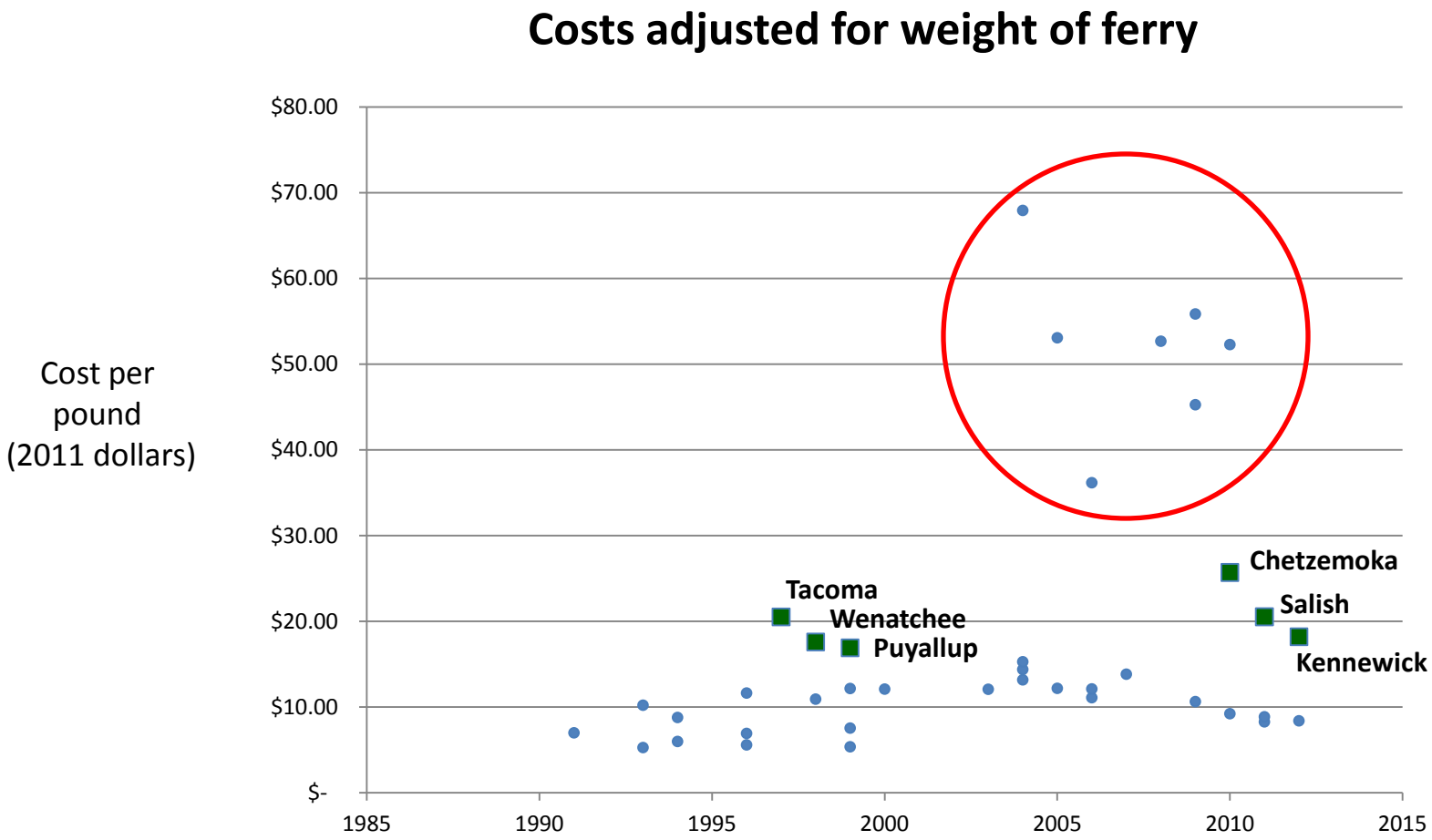
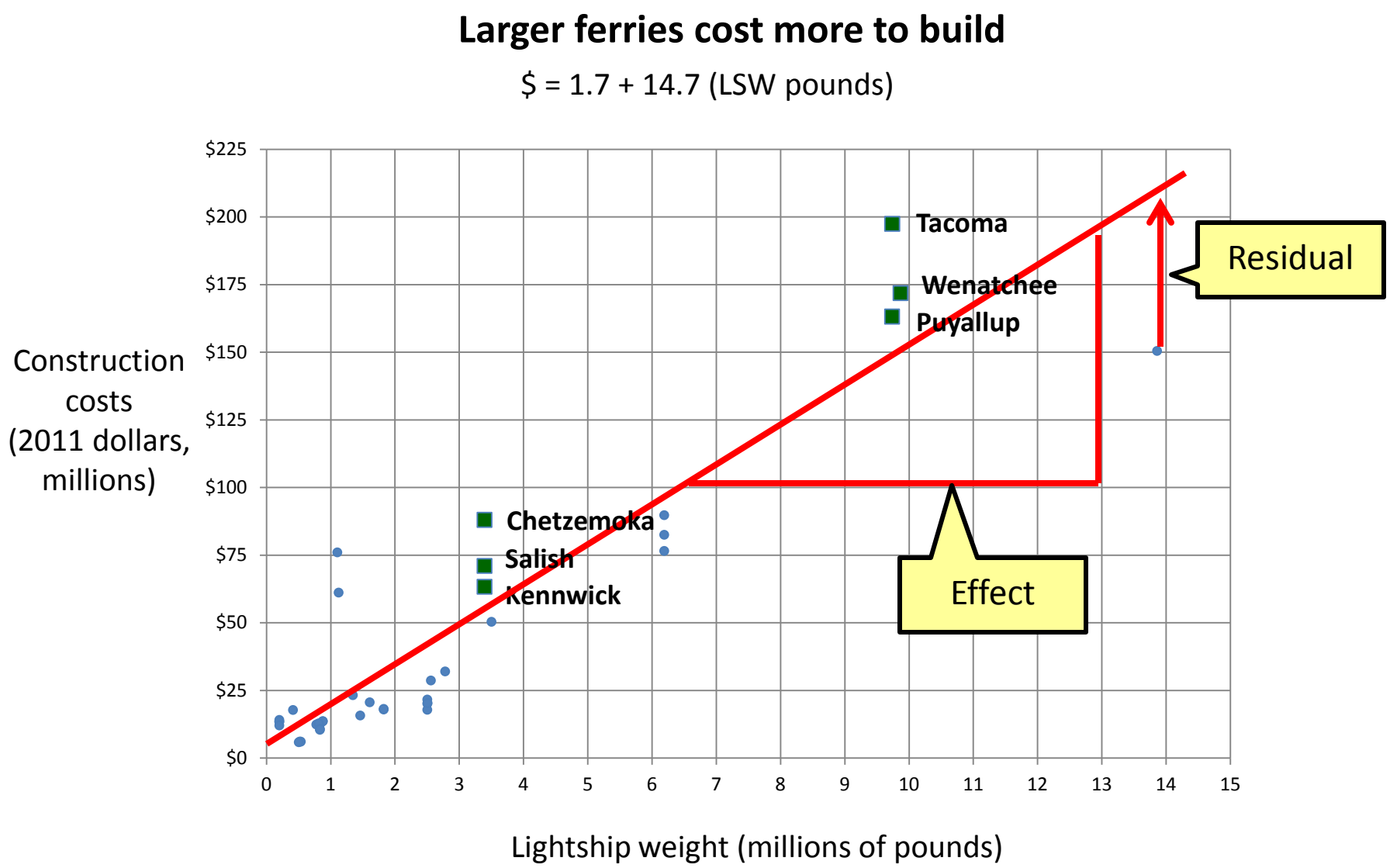


Primary cost drivers

Vessel characteristics	Operating environment	Purchasing characteristics
Lightship weight	Ocean	Purchaser
Passenger capacity	Lakes, bays, or sound	Location of shipyard
Vehicle capacity	River	Number of vessels in contract
Hull material	Route time	Days to delivery
Double-ended		Federal funding received
Horsepower		Amount of change orders
Passenger amenities		Any owner furnished equipment
Food service amenities		Number of bids received
Anticipated service life		Outsourced project management
Safety requirements		

Analytical Methods – Regression Model



Primary cost drivers used in the regression

Vessel characteristics	Operating environment	Purchasing characteristics
Lightship weight	Ocean	**Purchaser**
Passenger capacity	**Lakes, bays, or sound**	**Location of shipyard**
Vehicle capacity	River	Number of vessels in contract
Hull material	Route time	Days to delivery
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Passenger amenities		Any owner furnished equipment
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Anticipated service life		Outsourced project management
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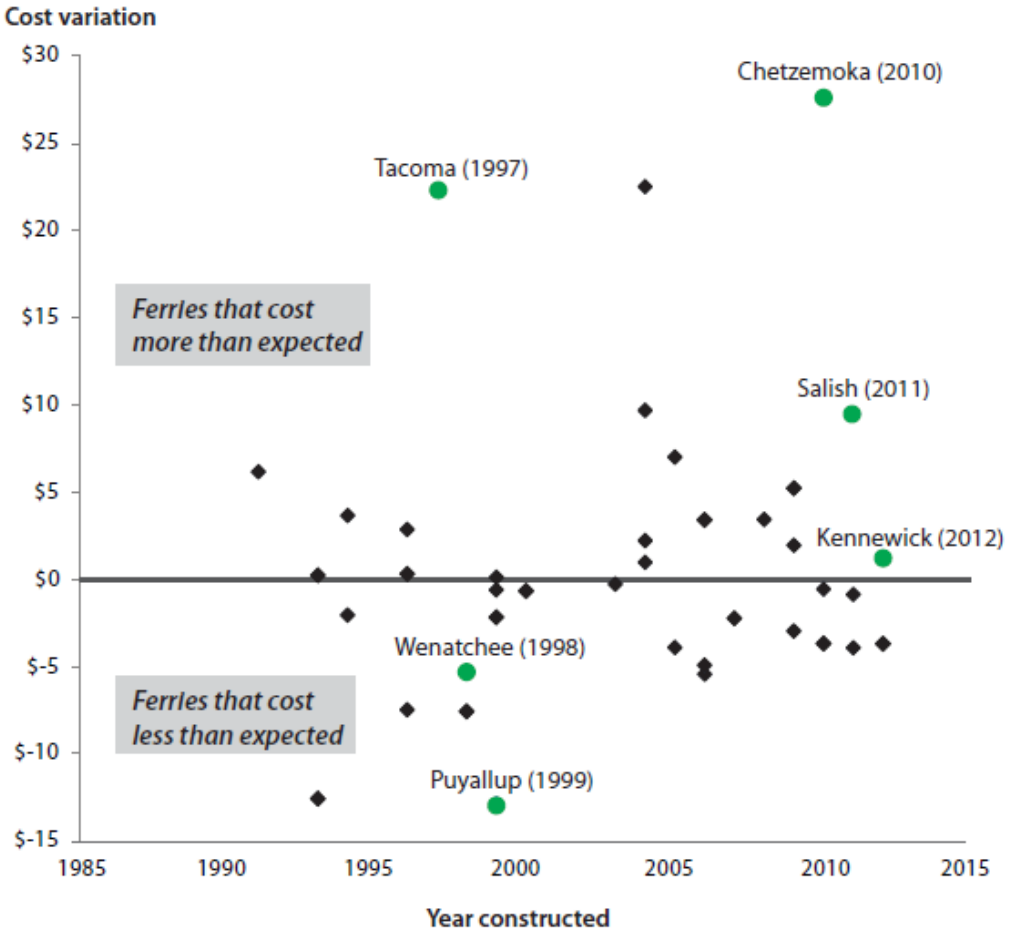
Costs when controlling for differences in design characteristics

Exhibit 9 - Comparing construction costs of 39 ferries when design characteristics are controlled for in the analysis

Dollars in millions, adjusted to 2011 value.
WSF vessels named (with construction year).



Source: Analysis of ferry purchaser data.

Strengths of our statistical analysis

- Conclusions are drawn from identifying patterns across multiple ferry construction projects.
  - We make the case that the expensive WSF projects of the past are not isolated incidences, but have systemic causes.
- We were able to control for multiple factors that drive ferry construction costs while comparing WSF to other purchasers
- We are able to estimate how much WSF has "overpaid" in the past. Is it a big deal?
  - We estimate that WSF paid between $7.5 million and $42.2 million more per ferry.

Limitations of our statistical analysis

- Our statistical analysis can not tell us why WSF paid more for ferries in the past.
- Our conclusions are only relevant if the patterns of the past are the same today.
- Our conclusions are only as good as the data are reliable and our assumptions are valid.
- Statistical analysis is a “black box” to most policy makers and program managers. If the results don’t make intuitive sense it is easy to dismiss them.

Analytical Methods – Case Studies

GAO defines a case study as:

"…a method for learning about a complex instance, based on a comprehensive understanding of that instance obtained by extensive description and analysis of that instance taken as a whole and in its context."

Case Studies – Why did we use them?

- To better understand the results of our regression model, which showed that WSF vessels cost most
- To understand the impact of the regulatory requirements we identified that are placed on WSF, but not other purchasers that built their ferries in Washington
- To understand improvements WSF had made in its vessel construction program
- To inform the development and our understanding of design and construction leading practices by learning about the practices of one of the most respected ferry operations in the world

Our case studies helped answer our audit questions

- *Chetzemoka/Island Home* construction cost comparison
  - Ferries cost more when WSF is the purchaser
  - Regulatory requirements placed on WSF limit competition and increase costs
  - Impact following construction and design leading practices has on cost
- Experience of Pierce County building the *Steilcoom II* in Washington
  - Ferries built in Washington, not by WSF do not cost more
  - Regulatory requirements placed on WSF limit competition and increase costs
- Improvements made in WSF practices between construction of Jumbo Mark II and Kwa-di Tabil class ferries
  - Impact following construction and design leading practices has on cost
- Design and construction practices at BC Ferries
  - Impact following construction and design leading practices has on cost

Chetzemoka/Island Home Case Study

The Island Home – Total cost $48 million
(2011 dollars)

The Chetzemoka – Total cost $87 million
(2011 dollars)

Pierce County Case Study

To illustrate the impact of open competition on price:

- Pierce County in Washington state builds and operates ferries, but is not subject to the Build in Washington law or the state's Apprenticeship Act
- The County issued a RFP to build a new ferry, but only received one bid from a local shipyard. The county cancelled the procurement because the bid was higher than their project estimate.
- After actively soliciting interest from other shipyards, the new procurement brought interest from nine shipyards, five of which bid on the project
- The winning shipyard, located in Washington, provided a bid that was 13% below the earlier bid

BC Ferries Case Study

What makes BC Ferries successful?

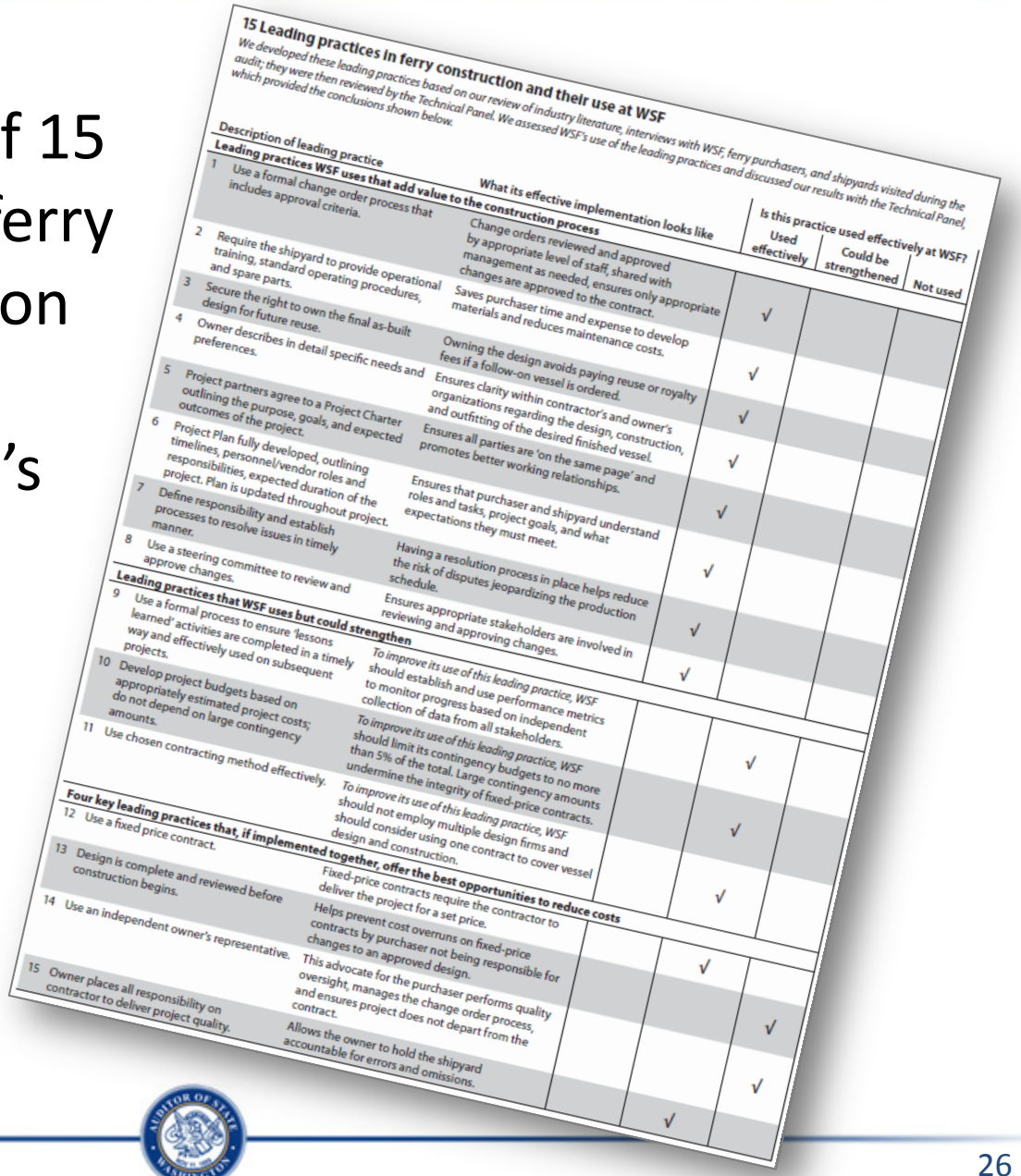
- Established vessel replacement criteria.
- Adopted a ‘functional specification’ approach to vessel design.
- Opened procurements to shipyards outside BC.
- Used fixed price contracts.
- Required shipyard to assume all responsibility for design and construction of new vessel.
- Made changes to construction contracts by using:
  - Design-build contracts
  - Price de-escalation clauses
  - Performance guarantees
  - Warranties
  - Right of refusal on final delivery

Case Studies – Strengths and Limitations

- Strengths
  - Case studies use multiple methodologies
  - Allows development of a complete understanding of what happened in a particular case
  - Provides an illustration of audit findings established through other methods
- Limitations
  - Selection is subjective
  - Generalization of results is limited
- Successful use of case studies depend on:
  - Ensuring the case study type and content is relevant to the audit question
  - Using a selection process that is credible and defendable

Analytical Methods - Leading practices

We developed a list of 15 leading practices for ferry design and construction contracting which we used to evaluate WSF's performance.



15 Leading practices in ferry construction and their use at WSF

We developed these leading practices based on our review of industry literature, interviews with WSF, ferry purchasers, and shipyards visited during the audit; they were then reviewed by the Technical Panel. We assessed WSF's use of the leading practices and discussed our results with the Technical Panel, which provided the conclusions shown below.

Description of leading practice	What its effective implementation looks like	Is this practice used effectively at WSF? Used effectively	Could be strengthened	Not used
Leading practices WSF uses that add value to the construction process				
1 Use a formal change order process that includes approval criteria.	Change orders reviewed and approved by appropriate level of staff, shared with management as needed, ensures only appropriate changes are approved to the contract.	√		
2 Require the shipyard to provide operational training, standard operating procedures, and spare parts.	Saves purchaser time and expense to develop materials and reduces maintenance costs.	√		
3 Secure the right to own the final as-built design for future reuse.	Owning the design avoids paying reuse or royalty fees if a follow-on vessel is ordered.	√		
4 Owner describes in detail specific needs and preferences.	Ensures clarity within contractor's and owner's organizations regarding the design, construction, and outfitting of the desired finished vessel.	√		
5 Project partners agree to a Project Charter outlining the purpose, goals, and expected outcomes of the project.	Ensures all parties are 'on the same page' and promotes better working relationships.	√		
6 Project Plan fully developed, outlining timelines, personnel/vendor roles and responsibilities, expected duration of the project. Plan is updated throughout project.	Ensures that purchaser and shipyard understand roles and tasks, project goals, and what expectations they must meet.	√		
7 Define responsibility and establish processes to resolve issues in timely manner.	Having a resolution process in place helps reduce the risk of disputes jeopardizing the production schedule.	√		
8 Use a steering committee to review and approve changes.	Ensures appropriate stakeholders are involved in reviewing and approving changes.	√		
Leading practices that WSF uses but could strengthen				
9 Use a formal process to ensure 'lessons learned' activities are completed in a timely way and effectively used on subsequent projects.	*To improve its use of this leading practice, WSF* should establish and use performance metrics to monitor progress based on independent collection of data from all stakeholders.		√	
10 Develop project budgets based on appropriately estimated project costs; do not depend on large contingency amounts.	*To improve its use of this leading practice, WSF* should limit its contingency budgets to no more than 5% of the total. Large contingency amounts undermine the integrity of fixed-price contracts.		√	
11 Use chosen contracting method effectively.	*To improve its use of this leading practice, WSF* should not employ multiple design firms and should consider using one contract to cover vessel design and construction.		√	
Four key leading practices that, if implemented together, offer the best opportunities to reduce costs				
12 Use a fixed price contract.	Fixed-price contracts require the contractor to deliver the project for a set price.		√	
13 Design is complete and reviewed before construction begins.	Helps prevent cost overruns on fixed-price contracts by purchaser not being responsible for changes to an approved design.			√
14 Use an independent owner's representative.	This advocate for the purchaser performs quality oversight, manages the change order process, and ensures project does not depart from the contract.			√
15 Owner places all responsibility on contractor to deliver project quality.	Allows the owner to hold the shipyard accountable for errors and omissions.		√	

Best Practices vs Leading Practices – What's the difference?

- Best practices – A best practice is a practice that is viewed as the most efficient and effective way of accomplishing a task, based on repeatable procedures that have proven themselves over time for large numbers of people
- Leading practices - A leading practice is a practice that is more efficient and effective for delivering a particular outcome, are dependent on the organization they are being applied to, and can change over time

Developing leading practices

- We developed leading practices for ferry design and construction based on:
  - Review of industry literature
  - Interviews with WSF
  - Interviews with eight ferry purchasers we visited
  - BC Ferries Case Study
  - Interviews with shipyards in and out of Washington state
  - Input from our technical panel of maritime experts

Leading Practices

- We assessed WSF performance against the leading practices by interviewing WSF executives and program managers; and reviewing WSF financial reports, contracts, and project management reports
- We reviewed the results of our assessment with our technical panel who provided their recommendations on how WSF could enhance the effectiveness of WSF's vessel construction program

Leading Practices – Strengths and Limitations

- Strengths
  - Developing leading practices specific to the audit allowed us to evaluate WSF performance against the leading practices of their peers
  - Assessing performance against leading practices allowed us to identify areas where WSF could improve their performance
- Limitations
  - Creating situation specific leading practices for an audit can leave others to question their credibility
  - Leading practices are not evidence-based, but based on the expertise of knowledgeable parties

Analytical Methods – Technical Expert Panel

- Panel members were selected to provide expertise in naval architecture, maritime regulation, vessel contracting, maritime law, and shipbuilding
- The technical panel reviewed, discussed, and provided feedback on our audit approach and results in a series of structured meetings
- The technical panel also evaluated the opportunities and trade-offs of making specific changes to WSF's current ferry construction policies and procedures, which helped us formulate our audit recommendations

Analytical Methods - Economic impact analysis

To estimate the economic impact of Build in Washington, we used the following assumptions:

- Build two ferries
- Costing $75 million each
- During fiscal years 2013 and 2014.

The results:

- An average of 322 jobs and $28 million in wages **in the shipbuilding industry** in each fiscal year.
- An average of 1,335 jobs and $90 million in wages **across all sectors of the economy** in each fiscal year.

Our thanks to OFM for using their Input-Output model to produce these estimates for our audit.

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