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Instituto Tecnológico de Costa Rica
Campus Tecnológico Central Cartago
Escuela De Ingeniería En Computación
Bases de datos I
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Preliminar #3 - Caso #3

1. Basado en su diseño, si existe una consulta que requiera al menos 4 joins, cuál opción sería más eficiente: encapsular el query en una vista dinámica o en una vista indexada. Si hay diferencia encontrar una justificación teórica que justifique el hallazgo. la cantidad de datos deben ser lo suficiente para encontrar diferencias

Consideramos que sería más apropiado implementar una **vista indexada** por las siguientes razones:

1. Suele tener un mayor rendimiento, ya que la tabla para almacenar los queries no debe ser creada en el momento que se ejecuta.
2. La base de datos de este caso tiene mucha información al tratarse de un sistema internacional. La gran complejidad de los queries y la alta densidad de datos hace que una vista indexada sea más adecuada para mantener un rendimiento adecuado.
3. Se puede usar una vista indexada para precalcular los resultados de la consulta y almacenarlos en la base de datos, lo que puede acelerar significativamente el tiempo de ejecución de la consulta.

View Indexado:

```
CREATE VIEW dbo.IndexedView WITH SCHEMABINDING AS
SELECT dbo.wasteMovements.wasteMovementId, dbo.wasteMovements.posttime, dbo.wasteMovements.quantity,
dbo.containers.containerName, dbo.wastes.wasteName, dbo.wasteTypes.typeName, dbo.producers.producerName,
dbo.countries.countryName
FROM dbo.wasteMovements
INNER JOIN dbo.wastes ON dbo.wasteMovements.wasteId = dbo.wastes.wasteId
INNER JOIN dbo.wasteTypes ON dbo.wastes.wasteType = dbo.wasteTypes.wasteTypeId
INNER JOIN dbo.addresses ON dbo.wasteMovements.addressId = dbo.addresses.addressId
INNER JOIN dbo.countries ON dbo.addresses.countryId = dbo.countries.countryId
INNER JOIN dbo.containers ON dbo.wasteMovements.containerId = dbo.containers.containerId
INNER JOIN dbo.containerTypes ON dbo.containers.containerTypeId = dbo.containerTypes.containerTypeId
INNER JOIN dbo.producersXmovements ON dbo.wasteMovements.wasteMovementId =
dbo.producersXmovements.wasteMovementId
INNER JOIN dbo.producers ON dbo.producersXmovements.producerId = dbo.producers.producerId
WHERE quantity > 400;

CREATE UNIQUE CLUSTERED INDEX ix_IndexedView ON dbo.IndexedView (wasteMovementId);
```

View Dinamico

```
CREATE FUNCTION dynamicViewProcedure (@minQuantity INT)
RETURNS TABLE
AS
RETURN
(
   SELECT dbo.wasteMovements.wasteMovementId, dbo.wasteMovements.posttime, dbo.wasteMovements.quantity,
dbo.containers.containerName, dbo.wastes.wasteName, dbo.wasteTypes.typeName, dbo.producers.producerName,
dbo.countries.countryName
   FROM dbo.wasteMovements
   INNER JOIN dbo.wastes ON dbo.wasteMovements.wasteId = dbo.wastes.wasteId
   INNER JOIN dbo.wasteTypes ON dbo.wastes.wasteType = dbo.wasteTypes.wasteTypeId
   INNER JOIN dbo.addresses ON dbo.wasteMovements.addressId = dbo.addresses.addressId
   INNER JOIN dbo.countries ON dbo.addresses.countryId = dbo.countries.countryId
   INNER JOIN dbo.containers ON dbo.wasteMovements.containerId = dbo.containers.containerId
   INNER JOIN dbo.containerTypes ON dbo.containers.containerTypeId = dbo.containerTypes.containerTypeId
   INNER JOIN dbo.producersXmovements ON dbo.wasteMovements.wasteMovementId =
dbo.producersXmovements.wasteMovementId
```

```
    INNER JOIN dbo.producers ON dbo.producersXmovements.producerId = dbo.producers.producerId
    WHERE quantity > @minQuantity
);

CREATE VIEW dbo.dynamicView AS
    SELECT *
    FROM dbo.dynamicViewProcedure(400)
```

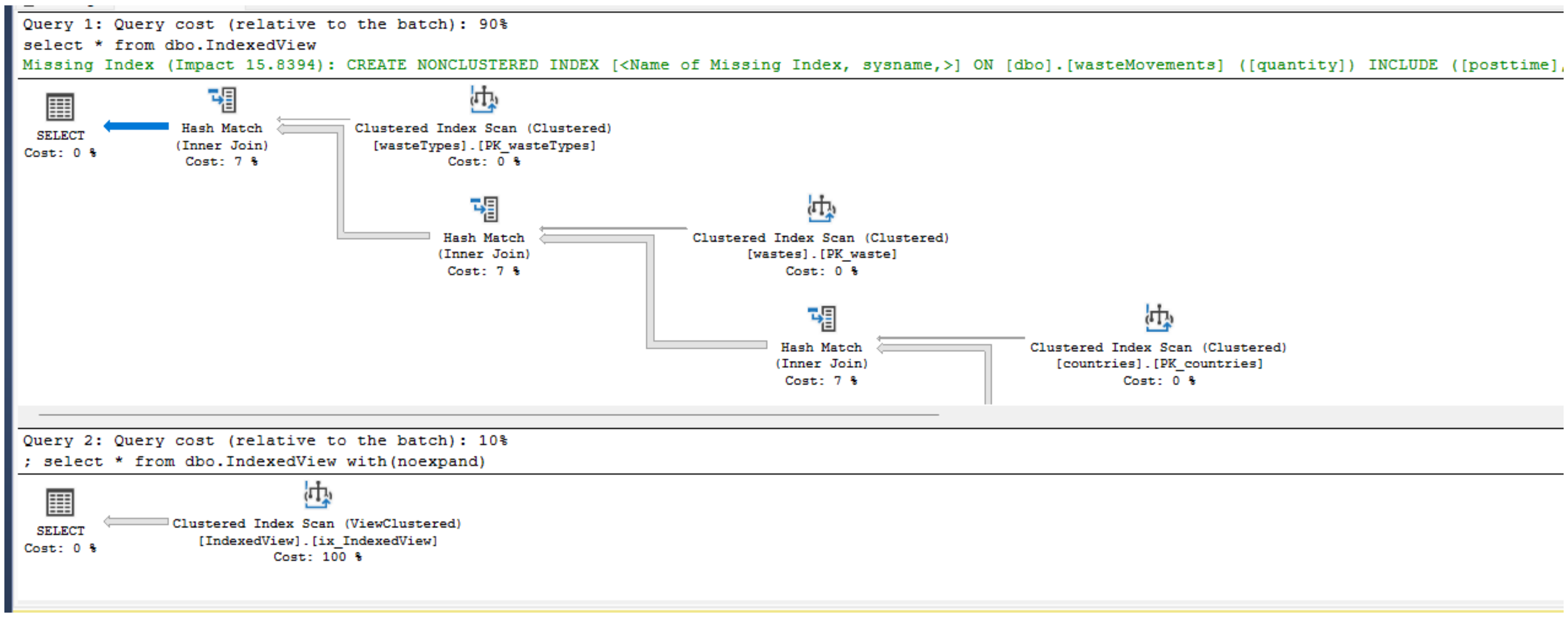
Statistics:

Original (sin indexar)	(144102 rows affected) Table 'Workfile'. Scan count 0, logical reads 0, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0. Table 'Worktable'. Scan count 0, logical reads 0, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0. Table 'producersXmovements'. Scan count 1, logical reads 564, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0. Table 'wasteMovements'. Scan count 1, logical reads 2412, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0. Table 'addresses'. Scan count 1, logical reads 3, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.

	Table 'producers'. Scan count 1, logical reads 2, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0. Table 'containers'. Scan count 1, logical reads 2, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0. Table 'countries'. Scan count 1, logical reads 2, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0. Table 'wastes'. Scan count 1, logical reads 2, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0. Table 'wasteTypes'. Scan count 1, logical reads 2, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Con clustered index	(144102 rows affected) Table 'IndexedView'. Scan count 1, logical reads 1479, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.
View dinámico	(144102 rows affected) Table 'Workfile'. Scan count 0, logical reads 0, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0. Table 'Worktable'. Scan count 0, logical reads 0, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0. Table 'producersXmovements'. Scan count 1, logical reads 564, physical reads 0, page server reads 0, read-ahead reads 0, page

	server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0. Table 'wasteMovements'. Scan count 1, logical reads 2412, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0. Table 'addresses'. Scan count 1, logical reads 3, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0. Table 'countries'. Scan count 1, logical reads 2, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0. Table 'wastes'. Scan count 1, logical reads 2, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0. Table 'wasteTypes'. Scan count 1, logical reads 2, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0. Table 'containers'. Scan count 1, logical reads 2, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0. Table 'producers'. Scan count 1, logical reads 2, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.

Se puede observar que para la vista original y dinámica se tuvieron que hacer alrededor de 3000 logical reads para cada una, mientras que en el clustered index solo se hicieron 1479.



```
Query 1: Query cost (relative to the batch): 90%
select * from dbo.IndexedView
Missing Index (Impact 15.8394): CREATE NONCLUSTERED INDEX [<Name of Missing Index, sysname,>] ON [dbo].[wasteMovements] ([quantity]) INCLUDE ([posttime],
```

SELECT
Cost: 0 %
Hash Match
(Inner Join)
Cost: 7 %
Clustered Index Scan (Clustered)
[wasteTypes].[PK_wasteTypes]
Cost: 0 %
Hash Match
(Inner Join)
Cost: 7 %
Clustered Index Scan (Clustered)
[wastes].[PK_waste]
Cost: 0 %
Hash Match
(Inner Join)
Cost: 7 %
Clustered Index Scan (Clustered)
[countries].[PK_countries]
Cost: 0 %

```
Query 2: Query cost (relative to the batch): 10%
; select * from dbo.IndexedView with(noexpand)
```

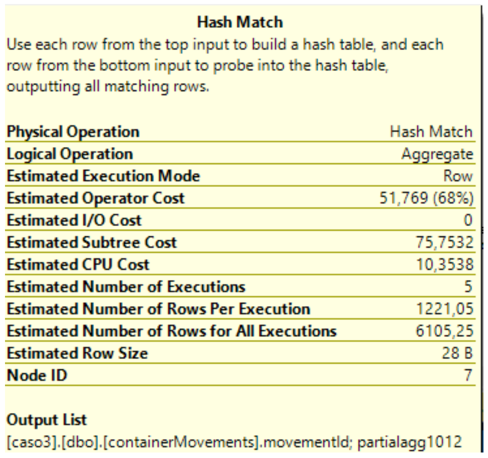
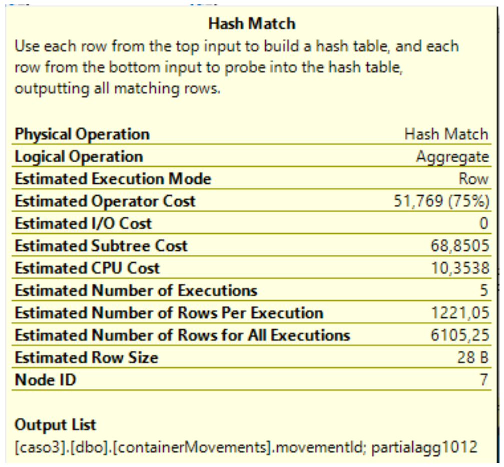
SELECT
Cost: 0 %
Clustered Index Scan (ViewClustered)
[IndexedView].[ix_IndexedView]
Cost: 100 %

3) Determinar una norma de estrategia de optimización para su diseño de base de datos, determinar una consulta real del sistema que contenga todos los componentes comunes de un query: fields, joins, left/right join, aggregate functions, except/intersect, group by, sort, for json, wheres sobre campos primary y non primary, igualdades y desigualdades. retornando una cantidad generosa de registros evalúe tiempos de ejecución y plan de ejecución de la consulta, y con ello diseñe un conjunto de pasos o normas, que debe seguir el equipo de desarrollo para garantizar que las consultas complejas se optimicen de una forma estandard y ordenada para la organización. Justifique cada normal con scripts ejemplos para hacer la demostración en tiempo real.

Original	Optimizado

SELECT
   p.producerName AS producerName,
   COUNT(DISTINCT cm.movementId) AS containerMoventCount,
   SUM(wm.quantity) AS totalWasteAmount
FROM
   producers p
LEFT JOIN
   producersXmovements pm ON p.producerId = pm.producerId
LEFT JOIN
   wasteMovements wm ON pm.wasteMovementId = wm.wasteMovementId
LEFT JOIN
   wastes w ON wm.wasteId = w.wasteId
LEFT JOIN
   containerMovements cm ON wm.containerId = cm.containerId
LEFT JOIN
   addresses ad ON wm.addressId = ad.addressId
WHERE
   ad.countryId = 1 AND
   w.wasteType = 2 AND
   cm.postime BETWEEN '2022-01-01' AND '2022-12-31'
GROUP BY
   p.producerName
HAVING
	SELECT
	   p.producerId AS producerId,
	   p.producerName AS producerName,
	   COUNT(DISTINCT cm.movementId) AS containerMovementCount,
	   SUM(wm.quantity) AS totalWasteAmount
	FROM
	   producers p
	   INNER JOIN producersXmovements pm ON p.producerId = pm.producerId
	   INNER JOIN wasteMovements wm ON pm.wasteMovementId = wm.wasteMovementId
	   INNER JOIN wastes w ON wm.wasteId = w.wasteId AND w.wasteType = 2
	   INNER JOIN containerMovements cm ON wm.containerId = cm.containerId AND cm.postime BETWEEN '2022-01-01' AND '2022-12-31'
	   INNER JOIN addresses ad ON wm.addressId = ad.addressId AND ad.countryId = 1
	GROUP BY
	   p.producerId, p.producerName
	HAVING
	   COUNT(DISTINCT cm.movementId) > 10

COUNT(DISTINCT cm.id) > 10
ORDER BY
totalWasteAmount DESC
FOR JSON AUTO;
	ORDER BY
	totalWasteAmount DESC
	FOR JSON AUTO;
	
	CREATE NONCLUSTERED INDEX [ixWasteMovement]
	ON [dbo].[wasteMovements] ([addressId])
	INCLUDE ([quantity],[containerId],[wasteId])

Unidad de workload	Explicación	Optimizado
 **Hash Match** Use each row from the top input to build a hash table, and each row from the bottom input to probe into the hash table, outputting all matching rows. **Physical Operation** Hash Match **Logical Operation** Aggregate **Estimated Execution Mode** Row **Estimated Operator Cost** 51,769 (68%) **Estimated I/O Cost** 0 **Estimated Subtree Cost** 75,7532 **Estimated CPU Cost** 10,3538 **Estimated Number of Executions** 5 **Estimated Number of Rows Per Execution** 1221,05 **Estimated Number of Rows for All Executions** 6105,25 **Estimated Row Size** 28 B **Node ID** 7 **Output List** [caso3].[dbo].[containerMovements].movementId; partialagg1012	Cuando se ejecuta la consulta, el hash mash se usaría para unir las tablas de producers, producerXmovement, waste, wasteMovements, containerMovments y address en sus respectivos Joins. Una vez que se unen los datos, las filas resultantes se agruparían por las columnas ProducerId y ProducerName y las funciones agregadas COUNT y SUM se usarían para calcular los valores decontainerMovementCount y totalWasteAmount.	 **Hash Match** Use each row from the top input to build a hash table, and each row from the bottom input to probe into the hash table, outputting all matching rows. **Physical Operation** Hash Match **Logical Operation** Aggregate **Estimated Execution Mode** Row **Estimated Operator Cost** 51,769 (75%) **Estimated I/O Cost** 0 **Estimated Subtree Cost** 68,8505 **Estimated CPU Cost** 10,3538 **Estimated Number of Executions** 5 **Estimated Number of Rows Per Execution** 1221,05 **Estimated Number of Rows for All Executions** 6105,25 **Estimated Row Size** 28 B **Node ID** 7 **Output List** [caso3].[dbo].[containerMovements].movementId; partialagg1012

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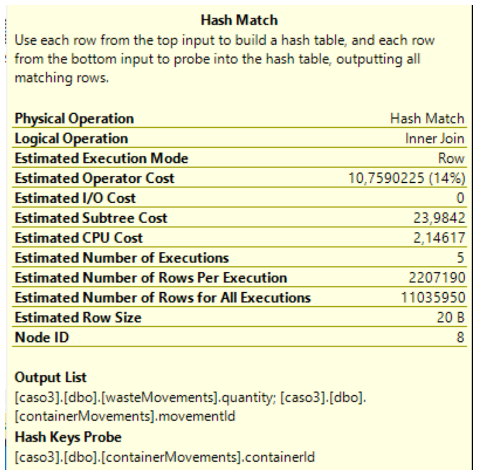


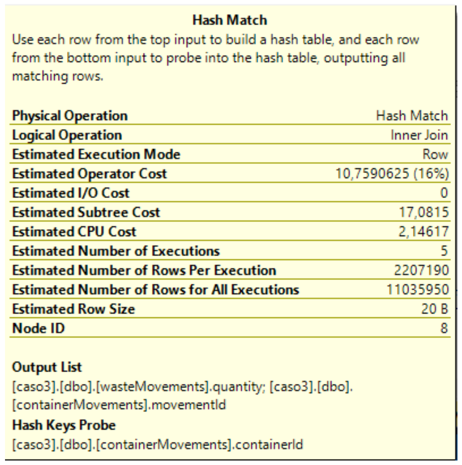
Hash Match

Use each row from the top input to build a hash table, and each row from the bottom input to probe into the hash table, outputting all matching rows.

Physical Operation	Hash Match
Logical Operation	Inner Join
Estimated Execution Mode	Row
Estimated Operator Cost	10,7590225 (14%)
Estimated I/O Cost	0
Estimated Subtree Cost	23,9842
Estimated CPU Cost	2,14617
Estimated Number of Executions	5
Estimated Number of Rows Per Execution	2207190
Estimated Number of Rows for All Executions	11035950
Estimated Row Size	20 B
Node ID	8

Output List
[caso3].[dbo].[wasteMovements].quantity; [caso3].[dbo].[containerMovements].movementId
Hash Keys Probe
[caso3].[dbo].[containerMovements].containerId

El engine esta utilizando de Hash Key Probe la llave de containerId, recorre cada wasteMovement y le hace hash al wasteMovementId para así juntar las tablas.

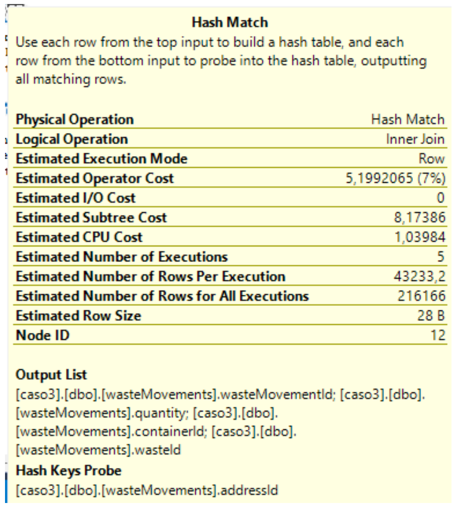


Hash Match

Use each row from the top input to build a hash table, and each row from the bottom input to probe into the hash table, outputting all matching rows.

Physical Operation	Hash Match
Logical Operation	Inner Join
Estimated Execution Mode	Row
Estimated Operator Cost	10,7590625 (16%)
Estimated I/O Cost	0
Estimated Subtree Cost	17,0815
Estimated CPU Cost	2,14617
Estimated Number of Executions	5
Estimated Number of Rows Per Execution	2207190
Estimated Number of Rows for All Executions	11035950
Estimated Row Size	20 B
Node ID	8

Output List
[caso3].[dbo].[wasteMovements].quantity; [caso3].[dbo].[containerMovements].movementId
Hash Keys Probe
[caso3].[dbo].[containerMovements].containerId



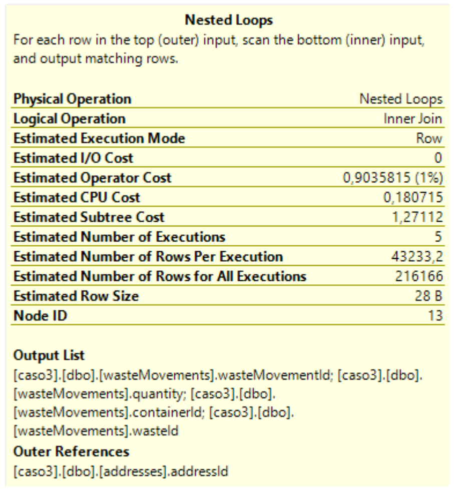
Hash Match

Use each row from the top input to build a hash table, and each row from the bottom input to probe into the hash table, outputting all matching rows.

Physical Operation	Hash Match
Logical Operation	Inner Join
Estimated Execution Mode	Row
Estimated Operator Cost	5,1992065 (7%)
Estimated I/O Cost	0
Estimated Subtree Cost	8,17386
Estimated CPU Cost	1,03984
Estimated Number of Executions	5
Estimated Number of Rows Per Execution	43233,2
Estimated Number of Rows for All Executions	216166
Estimated Row Size	28 B
Node ID	12

Output List
[caso3].[dbo].[wasteMovements].wasteMovementId; [caso3].[dbo].[wasteMovements].quantity; [caso3].[dbo].[wasteMovements].containerId; [caso3].[dbo].[wasteMovements].wasteId
Hash Keys Probe
[caso3].[dbo].[wasteMovements].addressId

El engine esta utilizando de Hash Key Probe la FK de addressId recorre cada wasteMovement para así obtener el quantity, el containerId y el wasteId.



Nested Loops

For each row in the top (outer) input, scan the bottom (inner) input, and output matching rows.

Physical Operation	Nested Loops
Logical Operation	Inner Join
Estimated Execution Mode	Row
Estimated I/O Cost	0
Estimated Operator Cost	0,9035815 (1%)
Estimated CPU Cost	0,180715
Estimated Subtree Cost	1,27112
Estimated Number of Executions	5
Estimated Number of Rows Per Execution	43233,2
Estimated Number of Rows for All Executions	216166
Estimated Row Size	28 B
Node ID	13

Output List
[caso3].[dbo].[wasteMovements].wasteMovementId; [caso3].[dbo].[wasteMovements].quantity; [caso3].[dbo].[wasteMovements].containerId; [caso3].[dbo].[wasteMovements].wasteId
Outer References
[caso3].[dbo].[addresses].addressId

Normas
Crear un índice en las columnas provenientes a FK de las tablas de mayor tamaño utilizados en la consulta Esto ayudará al motor de la base de datos a clasificar de manera eficiente el conjunto de resultados sin tener que realizar una exploración completa de la tabla o una clasificación temporal.
Cuando se realizan los INNER JOIN, es ideal colocar primeramente los filtros de las tablas con mayor cantidad de registros, así se logra disminuir la cantidad de datos que deben ser procesados.
Cuando se realicen JOINS, procurar que los WHERE se utilicen cuando se defina cada tabla que será utilizada en el query. Esto permitirá filtrar los datos inmediatamente luego de acceder a la tabla.

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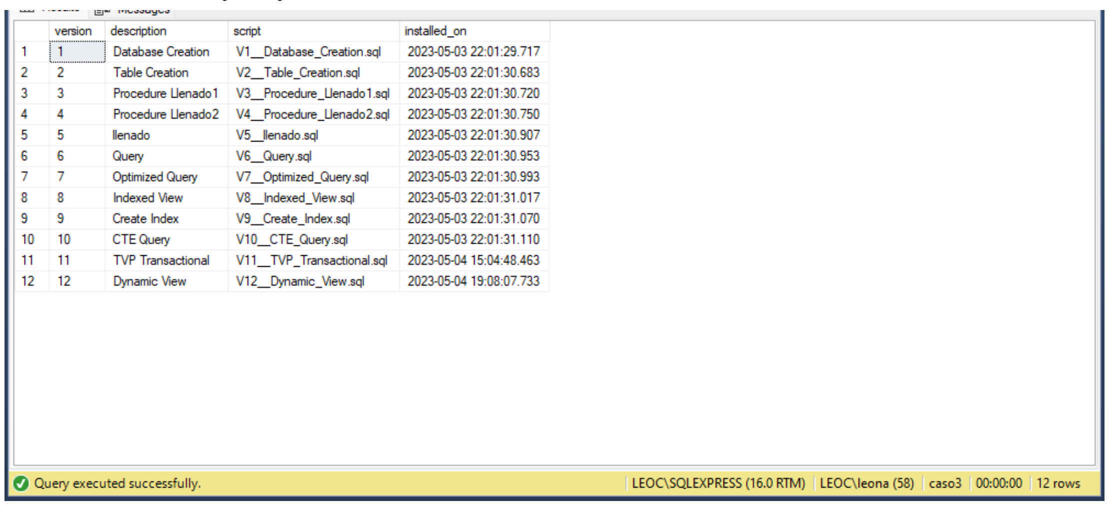
Evidencia del Flyway:



	version	description	script	installed_on
1	1	Database Creation	V1__Database_Creation.sql	2023-05-03 22:01:29.717
2	2	Table Creation	V2__Table_Creation.sql	2023-05-03 22:01:30.683
3	3	Procedure Llenado1	V3__Procedure_Llenado1.sql	2023-05-03 22:01:30.720
4	4	Procedure Llenado2	V4__Procedure_Llenado2.sql	2023-05-03 22:01:30.750
5	5	llenado	V5__llenado.sql	2023-05-03 22:01:30.907
6	6	Query	V6__Query.sql	2023-05-03 22:01:30.953
7	7	Optimized Query	V7__Optimized_Query.sql	2023-05-03 22:01:30.993
8	8	Indexed View	V8__Indexed_View.sql	2023-05-03 22:01:31.017
9	9	Create Index	V9__Create_Index.sql	2023-05-03 22:01:31.070
10	10	CTE Query	V10__CTE_Query.sql	2023-05-03 22:01:31.110
11	11	TVP Transactional	V11__TVP_Transactional.sql	2023-05-04 15:04:48.463
12	12	Dynamic View	V12__Dynamic_View.sql	2023-05-04 19:08:07.733

```
Query executed successfully.    LEOC\SQLEXPRESS (16.0 RTM) | LEOC\leona (58) | caso3 | 00:00:00 | 12 rows
```