An Analysis of Opportunities for Transformation in Kuwait's Crisis Decision Support Program

Course: INF1341: Systems Analysis and Process Innovation

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Executive Summary

This report evaluates previously proposed process improvements and explores transformation opportunities at the Crisis Decision Support Program (CDSP) at the Kuwait Institute for Scientific Research. The CDSP provides data support to various government agencies and is instrumental in fielding data requests during crises. The CDSP receives requests for retrieving data when a crisis happens. Its job is to either approve or deny the request, find the data, and send it back to the requester. Currently the CDSP's work process is completely manual based, which significantly reduces its work efficiency. As a result, the organization is in need of implementing a more automated system so that it can better serve its data delivery purpose.

In the report, the analysis models were created using i*. Besides the as-is situation, two to-be (transformation) alternatives were proposed to meet the CDSP's four soft goals: labour efficiency, accuracy, time efficiency and security. The pros and cons of the two alternatives were illustrated, as well as a comparison between the alternatives and the as-is situation from four perspectives: time, cost, quality and flexibility. In addition, three process alternatives were proposed for automation and innovation respectively. Automation alternatives include automating part of the CDSP's current work process. For innovation, all three alternatives include implementing a data base, but each with different functions. Lastly, a comparison was made between modelling using i*and other modeling techniques used previously.

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Context of the Study

The Kuwait Institute for Scientific Research is an independent national research institute that provides applied scientific research and technological consultations to both the governmental and private sectors in Kuwait. This report focuses on the Crisis Decision Support program (CDSP), a division of the Environment & Life Sciences research center. The division's mission is to provide the governmental branches of Kuwait with the critical data they require during a crisis so informed decisions can be made.

The current issues the Crisis Decision Support Program faces involve efficiency, timeliness, and redundancy. Optimizing and partially automating the program's data request processes is the program's current goal. To that end, this study examines their emergency response process, which involves obtaining the required data from any of Kuwait's government branches and then forwarding that data to the requesting government branch, to facilitate decision-making during a crisis. Examples of crises include oil spills, floods, power outages, etc. The number of data requests fielded by the CDSP can vary widely, from as few as five to as many as 150 in a month.

The CDSP's involvement streamlines data exchange by eliminating the need for the requesting party to know which government branch to contact for data, as well as the need for the providing party to obtain authorization to distribute this data. There are currently eighty-seven governmental bodies in the program, with each having differing levels of access to other branches' data depending on the crisis. Datasets and access rights are kept track of using an index maintained at the Crisis Decision Support Program and must be manually checked by a crisis officer before dispatching the data request. Requests are usually made by phone, and the requested data is usually sent via email, often as links to the data.

The previously identified major issue in this process is its manual nature, which leaves the system prone to human error and often leads to prolonged response times. Currently, the time it takes to process a request from start to finish can take anywhere from twenty minutes to multiple days depending on how often data is requested from an agency. Agencies like the Kuwait Meteorological Center can get multiple data requests within a short span (because of events like dust-storms) and quickly process such requests. Some agencies can go on for years without receiving a single data request; request processing times are most delayed here due to the lack of infrastructure and processes. This process and the required time it takes to perform is extremely critical. Time saved could result in improved public safety, and lives or costs saved.

As-Is Situation

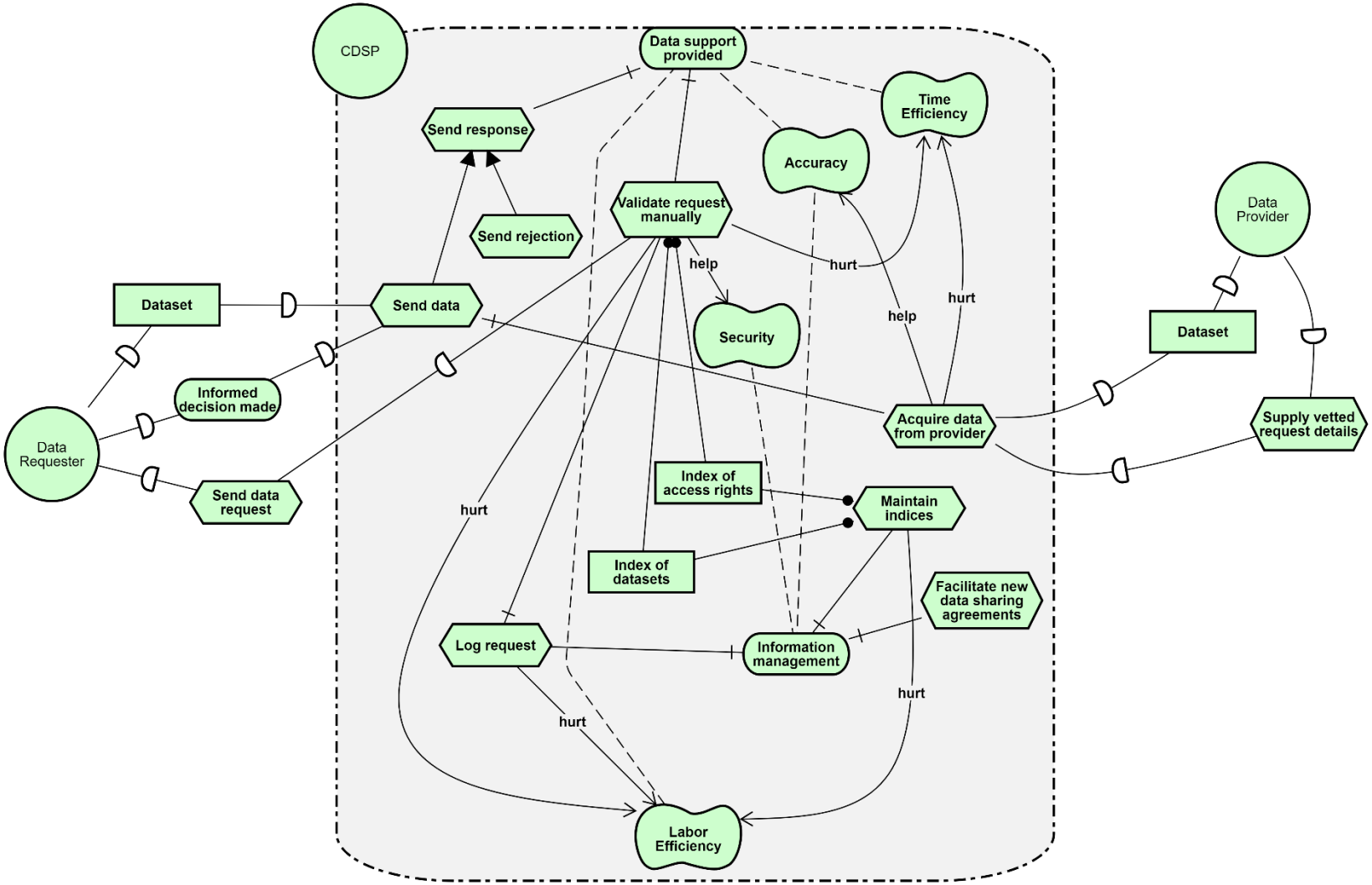

Figure 1: As-Is i Model*

Figure 1 depicts current strategic rationales and dependencies of various actors. The data requester is dependent on the CDSP to process their data request and to send the requested dataset as soon as possible in order to make informed decisions in handling the crisis. The CDSP depends upon the data requester to send in a data request so that the entire process may start. The data provider is dependent on the CDSP to supply thoroughly vetted request details, ensuring that the request is legitimate. The CDSP is dependent on the data provider to forward the appropriate dataset so they can send it on to the data requester. Currently, these external dependencies are largely met.

Internally, the CDSP has two primary goals. The first is its stated mission of providing information support to other government agencies, particularly in times of crisis. The second goal, information management, is implicit and was identified from conversations with the organization about their processes and priorities. Information management encompasses not only facilitating data requests, but also maintaining supporting datasets such as the indices and arranging for data sharing agreements between participating agencies, plus research and analysis duties conducted throughout the CDSP's parent organization, the Kuwait Institute for Scientific Research.

As for soft goals, four major ones were identified. The foremost of them is security. Information management is qualified by how well it guards information security and by extension national security: some of the datasets involved in the CDSP's processes are highly sensitive and would be dangerous in the wrong hands. Another soft goal is ensuring that information shared is current and fit-for-purpose; this quality has been modeled as accuracy. Finally, there are process-related soft goals of labour efficiency and time efficiency. Time efficiency entails completing processes quickly and minimizing delays. Labour efficiency involves carrying out processes without reduplicating efforts, and preferably by automating routine tasks.

Examining the CDSP's strategic rationales, we can see that while the agency is more or less able to meet the modeled goals, there are insufficiently satisficed soft goals, particularly labour and time efficiency. This finding aligns with earlier descriptions of delay and redundancy issues in the data request process and points to viability problems.

Time efficiency is hurt by both the manual request verification and data acquisition processes. Manual verification requires specially trained staff to check physical indices of available datasets and access rights, which is time-consuming. Afterwards, they must contact the provider agency. Miscommunications and missed calls create delays. Further delays occur when there is a crisis outside of normal government hours, as other agencies are not continuously staffed to handle data requests. Finally, the process of acquiring data is inefficient. Once the request has been communicated to a provider, the provider must download the data from their internal data stores and re-upload it to a location shared with the CDSP. This is time-consuming for large datasets and redundant for datasets that are requested more frequently than they are updated, as the provider agency must re-upload data each time. Altogether, requests currently take between a few hours to several days to process. The average request takes 3 hours to process, but this figure is skewed by the Meteorological Center's quick response times. That agency excepted, requests take an average of 1.5 days to process. Processing delays can be compounded by request volumes, with up to 150 requests in a month for severe crises.

Labour efficiency is similarly hurt by the manual request verification process, as well as by the manual tasks of maintaining auxiliary datasets: the analog data request log, index of available datasets, and the index of access rights. The former could be automated; the latter would require less effort if they were fully digitized.

While accuracy and security are helped in the current situation, as multiple manual checks help ensure that current, useful data is provided for legitimate requests, the long-term viability of current processes is threatened by the failure to satisfice labour and time efficiency soft goals. An extraordinary crisis risks overwhelming current processes and rendering them unworkable, should the CDSP fail to provide data support in time as a result of the previously detailed shortcomings.

In order to address the unmet soft goals and vulnerabilities of the process, two changes were proposed. The first proposed change was automating the data request process via the advent of a ticketing system to collect data on the data requestor. The information on the ticket would then be cross checked with digitized indices so that the crisis claim would undergo verification. Once all the checks were verified, the ticket would be forwarded to the data provider who would then contact the data requester directly.

The second proposed change was to introduce a central database to store data within the CDSP. After access verification and crisis confirmation, CDSP staff would call the data provider to ask if more recent data is available. If the datasets in the database are the most recent in version, then the data requestor is informed of the data and access is granted to the data requestor while the ticketing software grants permission to the data requestor to download the dataset. If recent datasets are available with the data provider, the provider is asked by the CDSP to upload the file to the central database. Once the upload is complete, the dataset can be downloaded.

To-Be Alternatives

Alternative One

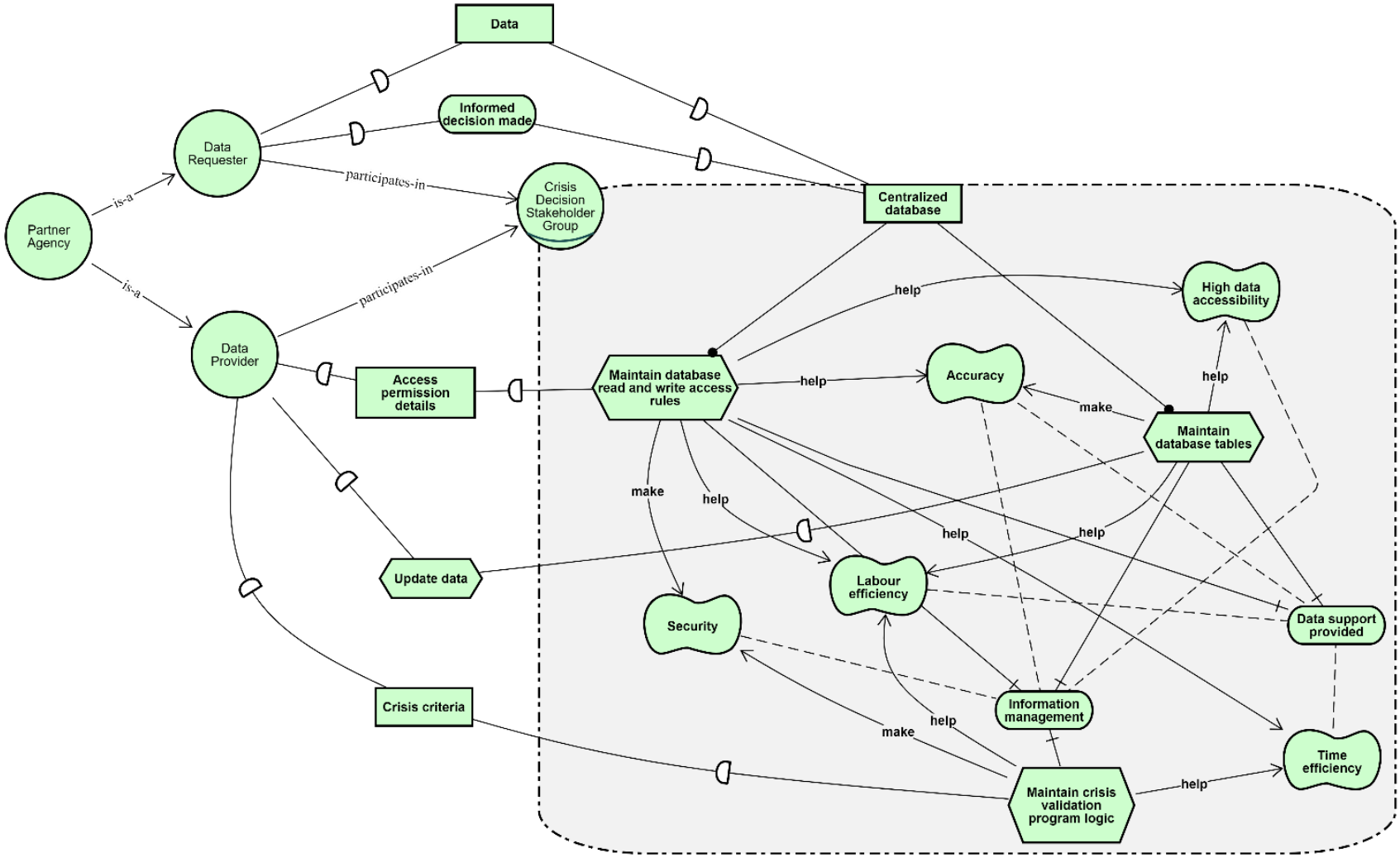

Figure 2: Hybrid Strategic Rationale/Strategic Dependency Model for Transformation Alternative One

Currently, the Crisis Decision Support Program (CDSP) is an intermediary between data providers and data requesters in the data exchange process. This transformation alternative proposes to dissolve the CDSP entirely; create a cross-functional crisis decision stakeholder group consisting of personnel from the partner agencies; and create and maintain a database for use by all agencies as a central repository for storing information.

The crisis decision stakeholder group would confirm and update user requirements for the central database. The group owns the database validation process and members participate in user acceptance testing as required when changes are made. Validation criteria include varying degrees of data access rights and criteria for determining a valid crisis. Stakeholder group members perform these tasks in addition to their primary job function i.e., they are both the builders and customers of the system.

Unlike the CDSP, which is a separate intermediary, this alternative builds the crisis data validation task into the roles of those who use the information. Once user-acceptance testing confirms that database and validation requirements have been met, the data is made available to users (i.e., a downtime may be involved overnight to update the database to ensure business continuity during the regular daytime hours). In this way, user-acceptance testing acts as a quality check to further validate the database criteria as required.

In addition, data stored in the database is updated by the users of the data, rather than an intermediary like the CDSP. Therefore, the data exchange process for requesting data is conducted by the same staff who require the information through one central database accessible to all agencies. To request access to data through the centralized database, the information requester needs only to click buttons on a user-friendly interface that runs a query on the database to generate information requested or to append information modifications or replacements.

Viability Analysis was used instead of the propagation of goal satisfaction values in SR models because it is difficult to model the organization's goals when the change being proposed includes the organization's dissolution.

From the i* model above, this transformation meets the CDSP's goals and can satisfice all soft goals. Individual users are still involved in quality assurance through the crisis decision stakeholder group. However, importing and exporting data is automated for all agencies. While this model results in increased flexibility since decision-makers can access data as needed, it introduces trade-offs necessitated by consensus-building during meetings with other members of the crisis decision stakeholder group. The result of balancing these trade-offs with the many benefits they provide is increased accuracy and increased data accessibility. However, for the increased accuracy it is assumed that data updates are timely. Realistically, there may be delays to updates, reducing accuracy gains.

This alternative assumes that the cost to obtain and maintain a database administrator is shared among other organizations. In addition, this alternative assumes a pathway to employ external vendors of record (VORs) to handle database administration – and that if such vendors were available, the long-term cost of maintaining this vendor relationship relative to the historically small-size agencies within the Kuwait government makes this option less-feasible. Finally, the introduction of an external vendor in part disrupts the very same principles championed by business process re-engineering i.e., the notion that information production and information use should involve the same actors/roles because it introduces an external holder of information who may not always adequately reflect the evolving needs of the agencies' requesting the data.

Additionally, in the i* model, the data request process improves labor efficiency by reducing the number of activities in request processing. It is clear that there are fewer activities involved when comparing the as-is model with the to-be transformation alternative because the central database performs the querying, exporting and importing of data.

It is a radical recommendation to propose dissolution of the very program interviewed for this study. However, by connecting the proposed alternative to the strategic soft goals of the government as a whole rather than just the CDSP, this alternative emphasized that both the CDSP and the broader government infrastructure actually have the same shared soft-goals and that a radical transformation can benefit all agencies within the broader government infrastructure – transcending the scope of CDSP.

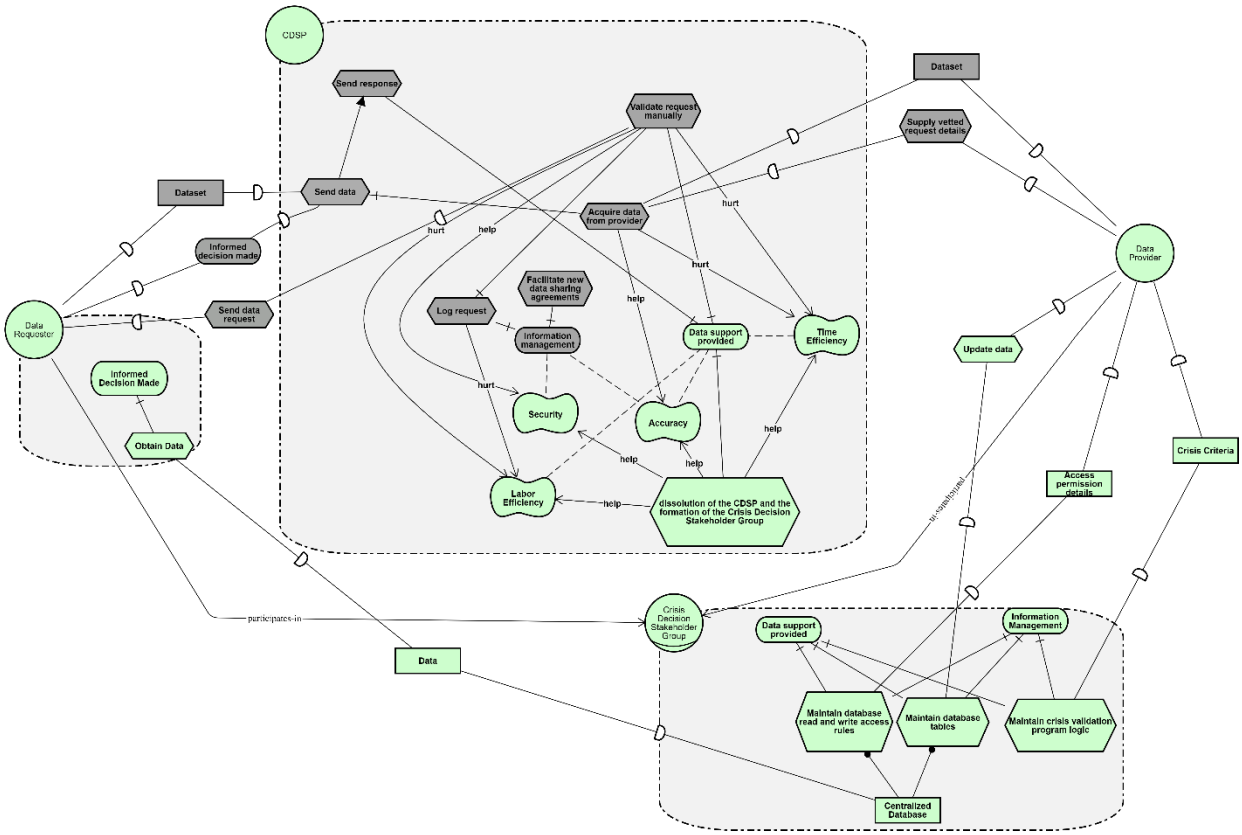

Figure 3: Viability analysis for Transformation 1. Grey shapes are elements from the as-is diagram; green shapes are elements of the proposed transformation.

In the viability analysis diagram shown above, a task of "dissolution of the CDSP and the formation of the Crisis Decision Stakeholder Group" is added to the CDSP. This is to show that the main goal of the CDSP is still being fulfilled while also satisfying the soft goals. The Crisis Decision Stakeholder Group is introduced to the same diagram to show how the other actors and roles that were interacting with the CDSP can still go about their routines and satisfy their goals through participation in the Crisis Decision Stakeholder Group.

Alternative Two

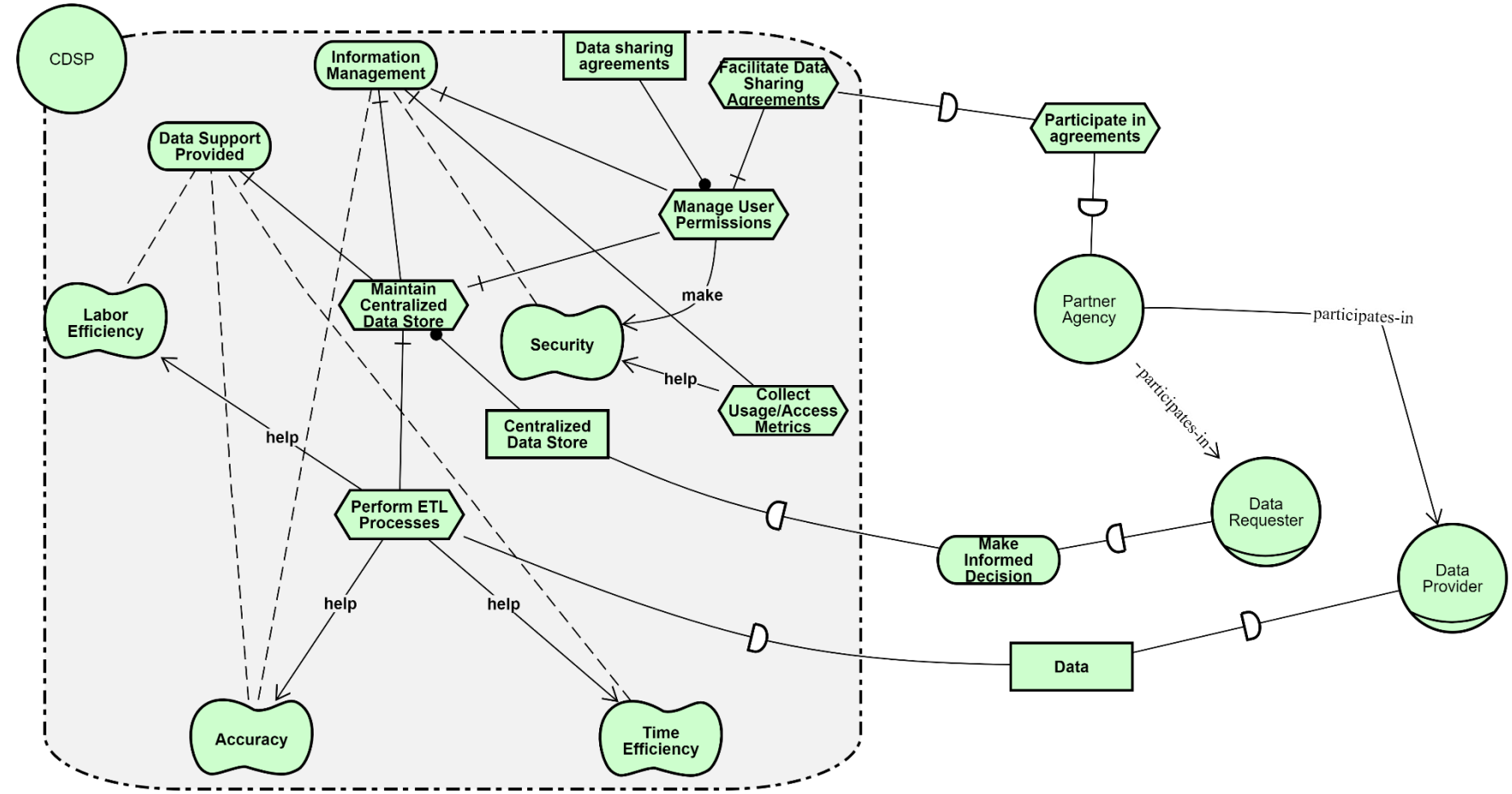

Figure 4: Hybrid Strategic Rationale/Strategic Dependency Model for Transformation Alternative Two

Another proposed transformation expands the CDSP's role as a data steward. As in the first alternative, there is to be a regularly updated, centralized data store containing datasets from each of the eighty-seven participating agencies. However, instead of dissolving the CDSP, the agency takes on a larger role in maintaining the database. Data in the centralized store can be updated by either automated push or pull processes. If the participating agency and CDSP have the technical capacity and a trusting relationship, the participating agency could push updated data to the centralized data store. Otherwise, an agency could alert the CDSP that a new version of the data is available at a particular location. The CDSP could then trigger an automated pull process to update the dataset. Access to data can be controlled with differential permissions according to agency or user role.

This proposed transformation then goes one step further. The CDSP would not simply house datasets as-is but would incorporate ETL (Extract, Transform, Load) processes to clean the data and improve interoperability. Depending on agency needs, these processes can include standardizing field names, normalizing measurement units, or creating crosswalks between categorical data value sets.

When an agency needs data, they would access this data store via an online portal. Once logged in, they could browse for datasets, access and download any they have permission for, and contact a listed point person for datasets they cannot access. The old request process is obviated entirely; the CDSP is a data steward, responsible for maintaining the portal and data store, as well as facilitating new data sharing agreements.

The above diagram depicts the proposed transformation. Managing user permissions meets the goals previously served by request and crisis validation. Incorporating ETL processes into the data store better satisfices efficiency and accuracy goals. By modeling "data provider" and "data requester" as roles of a partner agency, we can see that strategic dependencies have been reduced. Agencies no longer rely on the CDSP for vetted requests, only on the data store for decision support. The CDSP no longer needs agency requests, just their data and participation in access agreement negotiations.

This transformation would require a cultural change throughout the government. As is, agencies operate on a need-to-know basis with respect to data sharing. Access rights are tightly controlled, with agreements operating on a dataset-by-dataset and crisis-by-crisis basis. Under this transformation, data access would be granted on an agency or role basis; there would be no more crisis verification. This transformation would only be successful if culture changes to allow for more open data sharing between agencies. This can be incremental, such as opening access to one dataset to an agency for any reason, or making only summary data widely available, with instructions on how to contact the agency for more granular data. While such a change may be stark for the CDSP, these practices align with those of other interagency data sharing arrangements, such as those between US law enforcement agencies.

In terms of impact, this transformation is costly, with short-term costs for infrastructure and data management upgrades and long-term maintenance costs, as well as costs to for personnel to act as data stewards and database administrators. However, this option offers major time and quality improvements once implemented. Agencies can get data much more quickly in times of crisis, saving lives and money. This data would also be guaranteed current and would be easier to integrate with other datasets.

Detailed Viability Analysis of Second Transformation

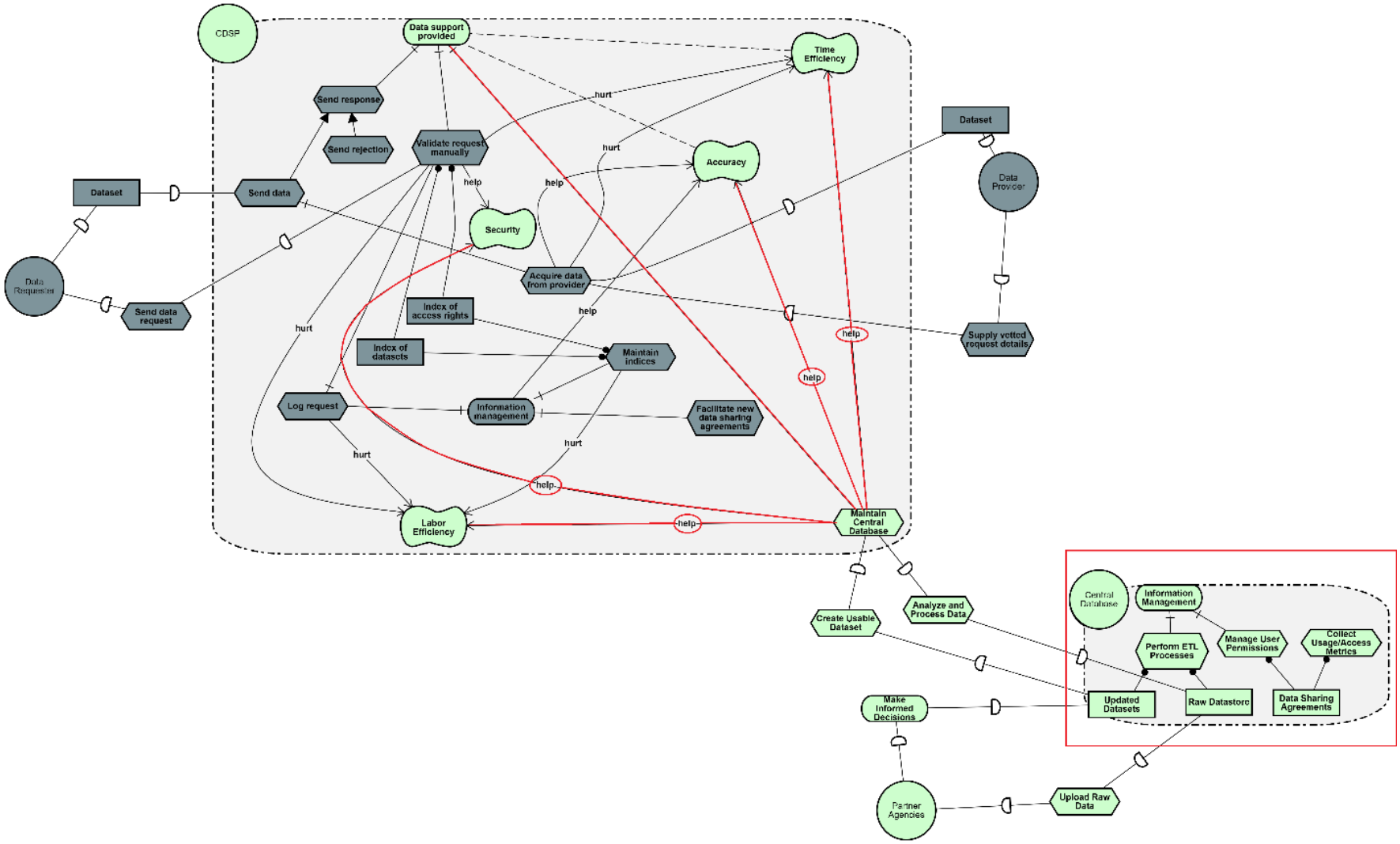

Figure 5: Viability Analysis of Transformation 2. Grey shapes are elements from the as-is diagram; green shapes are elements of the proposed transformation.

In the viability analysis above, the proposed database has been extracted as an actor to show which goals and processes are impacted the most with this transformation and to improve discernibility of the diagram.

Adding the central database to the As-Is model satisfies all of the CDSP's soft goals of security, accuracy, labour efficiency and time efficiency, indicating that transformation is a viable alternative. As previously mentioned, current processes hinder the satisficing labour efficiency and time efficiency soft goals. With a central database, checking for datasets, validating access rights, and logging request details can be incorporated into database administration tasks such as user permission management and access logging. The data distribution process is faster as users can access their desired dataset within minutes versus the current situation where data provision can take from 20 minutes to days.

This transformation differs from earlier proposed innovations in that there is a significant restructuring of the CDSP's strategic rationale and organizational dependencies. The CDSP's organizational role has shifted towards data stewardship; they not only upload data to a centralized database but coordinate and perform regular updates and data integration.

As seen in in the to-be i* model, there is no longer any distinction between data provider and data requester; there are simply partner agencies that play both roles at different times. With the new set-up, every agency provides raw data and can download usable datasets, according to their access rights. Another distinction is that the central database now has datastores for two different types of data: Raw Data and Updated Datasets. Research into other intergovernmental sharing agreements revealed that data integration was key to facilitating data sharing. Infrastructure must be in place to coordinate data updates and ensure that data definitions and units are standardized. This often entails maintaining an operational data store for unintegrated data in addition to the centralized data store for processed data. This aids the partner agencies in achieving their goal of making informed decisions in a more timely manner.

The tasks of analyzing the raw data and extracting and sifting the available information into specially curated datasets both go into the task of maintaining the central database. This abstracted task (shown inside the CDSP actor) then satisfices all the soft-goals, as many of the tasks previously performed by the CDSP are now done in an automated manner by the database system.

Comparison of To-Be Alternatives

The two proposed transformation alternatives are evaluated against multiple frameworks below.

Alternative 1:

Pros	Cons
• Pre-validated access rights: data agreements created in a cautionary approach instead of a 'need-to-know-basis' • Continuous human oversight; ensures high accuracy and quality of datasets • Improved time efficiency due to high accessibility of required datasets • Improved labour efficiency due to automation of data request and retrieval • New process helps other government agencies achieve soft-goals of time and labour efficiency, security and accuracy • Cost of database maintenance distributed between partner agencies – potential cost decrease	• Hard to convince an agency to dissolve itself • Predetermined access rights and automated crisis validation leaves system open to being gamed by bad actors • New dependency if external vendors are used for database maintenance • Success dependent on staff in 87 agencies adopting new duties well • Possibility of silo'd communication and knowledge gaps within the stakeholder group if participation levels vary between agencies • Risk of database becoming a data swamp, with different data standards creating confusion

Alternative 2:

Pros	Cons
• Readily available information • Fewer delays in communication • Easily interpretable datasets can make decision making faster • Actor objectives satisfied: CDSP goal of data provision and government agency goal of receiving correct data for informed decision making • CDSP's implicit information management goal is better fulfilled • Soft goals satisficed: time and labour efficiency, accuracy, security	• Costly, brand new database system and infrastructure needed for functioning system • Success dependent on government-wide acceptance of open data sharing • Additional data processing dependency added on CDSP

The following table compares the as-is process to the to-be models relative to four benchmarks captured in the devil's quadrangle i.e., cost, time, flexibility and quality:

	As-Is	**Alternative 1 (Dissolve the CDSP)**	**Alternative 2 (CDSP as data steward)**
Summary	**(current state)**	**C+/- | Q+/- | T+ | F+/-**	**C+ | Q+ | T+ | F+/-**
Cost	• 95% of the process occurs manually, which is costly	• Uses existing staff in other agencies, lowering cost • Added database maintenance costs (infrastructure + admin)	• Added database maintenance costs (infrastructure + admin) • Creating and maintaining ETL processes can incur additional costs (requirements gathering, testing, coding)
Quality	• 100% accuracy rate identifying crisis situations • Manual process leaves room for human error • Lags in response times affect quality	• Staff in other departments/agencies validate criteria and participate in user acceptance testing resulting in a data store that better serves their needs • Potential quality reduction if existing staff cannot devote adequate time to new duties	• ETL processes produce cleaner, easier-to-integrate datasets. Errors can be removed; field names measurements and definitions can be standardized; and summary figures can be pre-calculated
Time	• Manual process slows things down	• Reduced turnaround times, as personnel can pull data as needed	• Reduced turnaround times, as personnel can pull data as needed
Flexibility	• Manual process allows for flexible rule interpretation, data need and crisis severity assessments	• Increased flexibility since decision-making, and data processing occur in the same place • Possible flexibility reduction in situations not covered by program logic	• Faster data retrieval can lead to more flexibility: agencies can explore and pull data as their needs change • Possible flexibility reduction in situations not covered by program logic

From the tables above, it is clear that both transformations help satisfice the CDSP's soft goals. There are advantages and disadvantages to each alternative. In transformation one, a new dependency is created on an external vendor who maintains the database. Costs to maintain the database are distributed amongst the users so it is a cost-effective option. In transformation two, more specialized processing of the data is done and the database is maintained mainly by the CDSP, both of which make this the more expensive of the two options but also makes it the option with the fastest path to making an informed decision.

Three principles of business process re-engineering (BPR) are captured by Transformation Alternative One. These principles include principles that prevent redundant repeat requests for the same data; principles that reduce the emergence of hyper-specialized departments like the CDSP and allows for decision-makers to be involved in the data production and principles that allow those who process information to also be involved in producing information. Transformation Alternative Two captures all five principles of BPR: The centralized database introduced here stores all the information at one place, when it is uploaded from different agencies. The raw information is then cleaned into usable datasets and stored in the database for appropriate agencies to use. The data providers are also the data requestor. Control is built into the process by being baked into the infrastructure; user access is authorized against data-sharing rules that the participating agencies agree upon.

Given the benefit and drawbacks of each alternative in the tables above, Alternative one will be a better choice is the number of requests made in a month remains the same as the current situation (between 5 and 50). This is because this alternative makes the best use of the currently available resources and the demand for data is manageable and faster given the level of automation suggested here. Alternative two is a better choice if the monthly minimum of requests starts at the 150 mark. A more intensive management process and strong infrastructure is needed to keep up with the data demand and ensure agencies can make their decisions as fast as possible; the pre-processed data suggested by alternative two is a needed for this to happen.

Comparison of Process Alternatives

Process Automation Alternatives

Description

The three automation alternatives that were evaluated focused on request validation, as it is the main bottleneck in the request process and a key component in ensuring that the data is shared only with those who have a legitimate claim to access it. Thus, the automation goals mainly maneuvered toward automating request validation tasks, including ensuring the requested data existed and checking that the requester had access rights to the data given the crisis.

The first alternative was to automate the entire request validation process. Request availability and access rights would both be checked by a computer program. If the requested data existed and the requestor had access rights according to the program's logic, the request would automatically be approved and forwarded to the appropriate providing agency. Not only does this automation alternative ensure that the most current version of the data is shared, but the automation speeds the process flow for the CDSP.

The second alternative was to automate data availability and access rights validation while creating a manual crisis verification step. In this alternative, a computer program would confirm that extant data is being requested and that the requesting party has access to it under one or more data sharing agreements. Unlike the first alternative, the request would not be automatically forwarded to the appropriate data provider upon validation. Instead, the validated request ticket would go to CDSP personnel for manual confirmation of crisis occurrence and severity.

The third alternative was to introduce a program to check if the data has been requested or provided before. If the data has been requested or provided before, the system will skip checking the access rights and simply approve the request. Similar to the first automation alternative, this alternative also supports a faster process flow. It also makes more use of the request log, which in the current state and the other proposed alternatives goes largely ignored.

In all three alternatives, preexisting data stores (the indices of datasets and access rights and the request log) would need to be digitized. The digitization would incur a greater one-time cost, but even if no further changes were introduced, it would benefit the organization greatly. Maintenance of the indices would be easier; indices would be searchable, saving time; physical storage requirements would decrease; and the CDSP would not be so reliant on unwritten, informal knowledge held by one or two experienced personnel.

Analysis with Goal Models

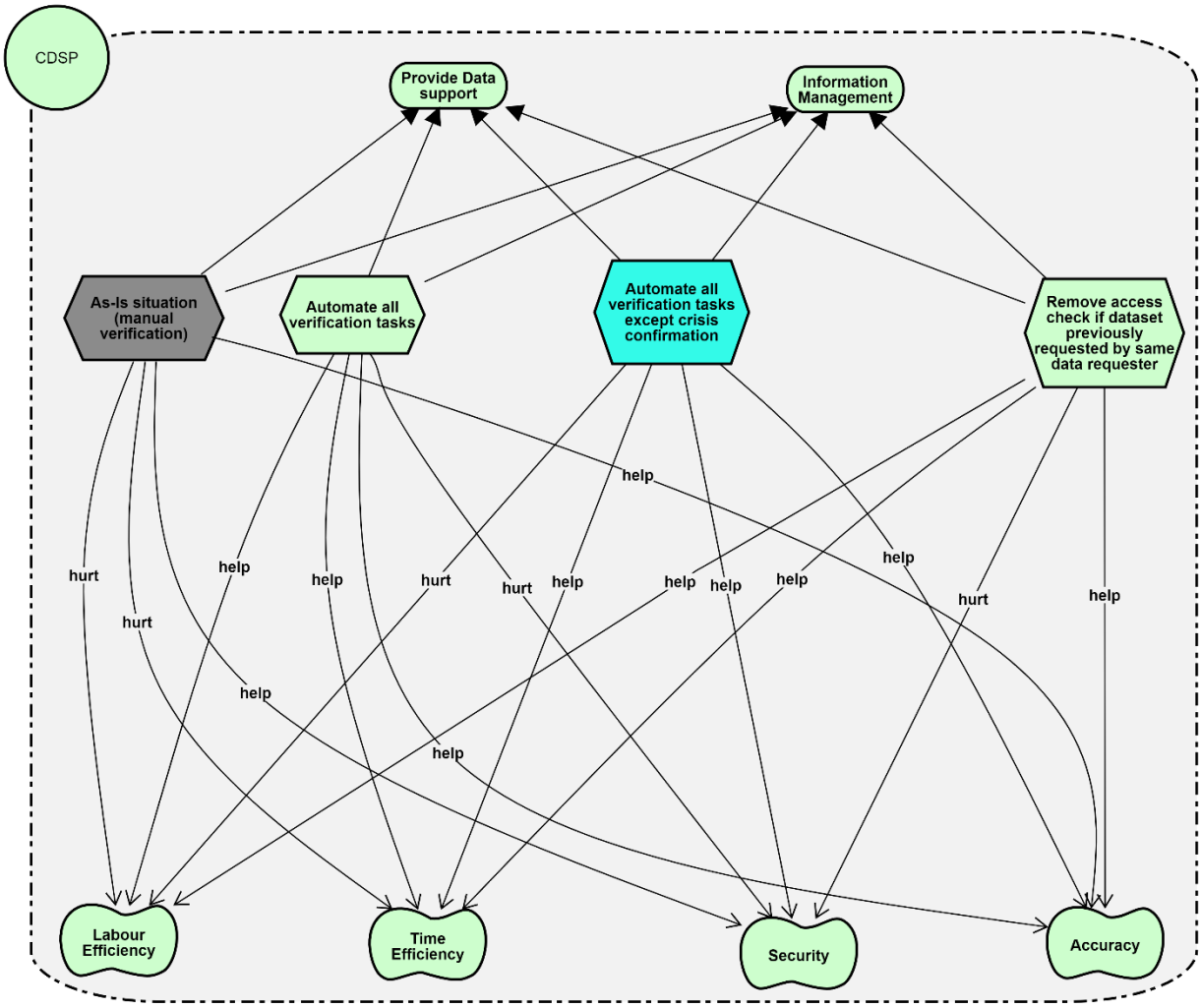

Figure 6: Automation Alternatives Goal Model

Above is the automation alternatives goal model depicting hard and soft goals that the CDSP needs to achieve. Each alternative aims to accomplish the goals of providing data support and information management while satisficing the soft goals of accuracy, considered to be delivery of current and fit-for-purpose data, security, time efficiency, and labour efficiency.

However, while each alternative accomplishes all goals, they do not satisfice every soft goal equally. Identifying which automation alternative helps the most soft goals is the central focus of this analysis. The goal model helps show why the automating all verification tasks except crisis information is the best of the automation options proposed for the CDSP.

The as-is state, shown on the far left, meets the goals of information management and providing data support, but insufficiently satisfices two of the four soft goals. The manual nature of the current request verification process is inefficient both time-wise and labour-wise. As detailed in the description of the as-is situation, requests can take several days and multiple people to process.

One alternative, shown on the far right in the goal model, is to remove the access check if the dataset was previously requested by the same data requester. This option passes ability evaluation: it is feasible to write a program that performs the check. This alternative is also workable: all goals can be satisfied if external dependencies are met. However, from a viability perspective this alternative does not satisfice all soft goals. Security is compromised. Data sharing agreements lapse and change; just because an agency could previously access the data does not mean they have access rights in perpetuity going forward. In addition, time and labour efficiency gains are minimal. This process of automatically approving previously requested datasets will speed turnaround on requests made to the most responsive agency, but the biggest problems with the process lie with requests made to agencies that rarely get them. This proposal does nothing to improve time or labour efficiency in those cases.

Automating request validation entirely, depicted second on the left in the goal model, is another alternative that the CDSP would be able to implement. It is also workable, with the dependencies left largely unchanged from the current workable state. Requesting agencies would have to supply details of their request to the CDSP; the forwarding agency would rely on the CDSP to forward approved requests. The requester would rely directly on the provider to send the requisite dataset, taking that dependency out of the CDSP's consideration.

This alternative also has viability issues. As in the first alternative discussed, security is compromised. Automating all verification tasks contributes a potential deficiency in security should a malicious actor game the request system, such as by requesting data for which an access agreement exists but where there was no real need, i.e., by claiming a false crisis to access data fraudulently. Further checks, such as additional crisis validation program logic or manually sampling requests for validity, would be necessary to help satisfice security. The latter would be easier for the CDSP to implement but would also reduce labour efficiency gains offered by this alternative.

The final alternative, shown in blue in the center right, is automating all verification tasks except crisis information. As with the other two alternatives considered, this option meets assessment criteria for ability and workability, assuming external actors continue to fulfill dependencies and there is an adequately designed ticketing system with appropriately coded logic to confirm access rights. In terms of viability, this alternative is still not perfect. The manual crisis verification check can hurt labour efficiency, since it adds a task that was previously not codified. Although labour efficiency is not fully satisficed, it is better served than it is in the current state. Confirming crisis existence and severity is less labour-intensive than the current manual checks.

This alternative is preferred because the only compromised soft goal is labour efficiency; in addition, it is the only one of the three alternatives to help security. While the CDSP would like their processes to make efficient use of their personnel's time and skills, labour efficiency is not as critical a soft goal as information security.

Process Innovation Alternatives

Description

For the automation alternative, we proposed adding an automated system to the process. When a request is sent, the system checks the access rights first before forwarding it to the CDSP. If the requester does not have access rights to the data, the system automatically rejects the request without forwarding to the CDSP. A drawback of the current manual process is slow response time: people cannot react faster than an automated system. With this system implemented, the requester would receive a response in less time, which is important in a crisis.

Our innovation alternatives include all the changes mentioned in the automation process above. Additionally, a database is introduced in our three innovation alternatives, each having different functions.

The first innovation alternative is to establish a daily updated central database at the CDSP in addition to the automation process. The database's role is to hold the data regardless if it has been requested or not. By having such database, it would reduce the time for manual confirmation of the latest data versions, as well as minimize CDSP's workload because it no longer has to contact the data provider for data.

The second innovation alternative is to have a database that can hold previously sent data. This data would be directly forwarded to the requesting party if it is the newest version. For example, if the same data has been requested by two different parties, the system is able to detect that. Once the system approves the second request, the database can directly forward the data. This would also save time for the CDSP and eliminates the redundancies of re-requesting and re-uploading previously requested and provided data.

The third innovation alternative is to implement a database with data decay rules. Instead of manually updating the database with new data at the time of the request, data would expire in a given time frame, such as a month or a week, depending on the nature of the data. This would eliminate the need to check if data available in the database is current. Also, it can enhance data security and protection. For example, if the database were ever compromised, not every dataset ever stored would be exposed.

Analysis with Goal Models

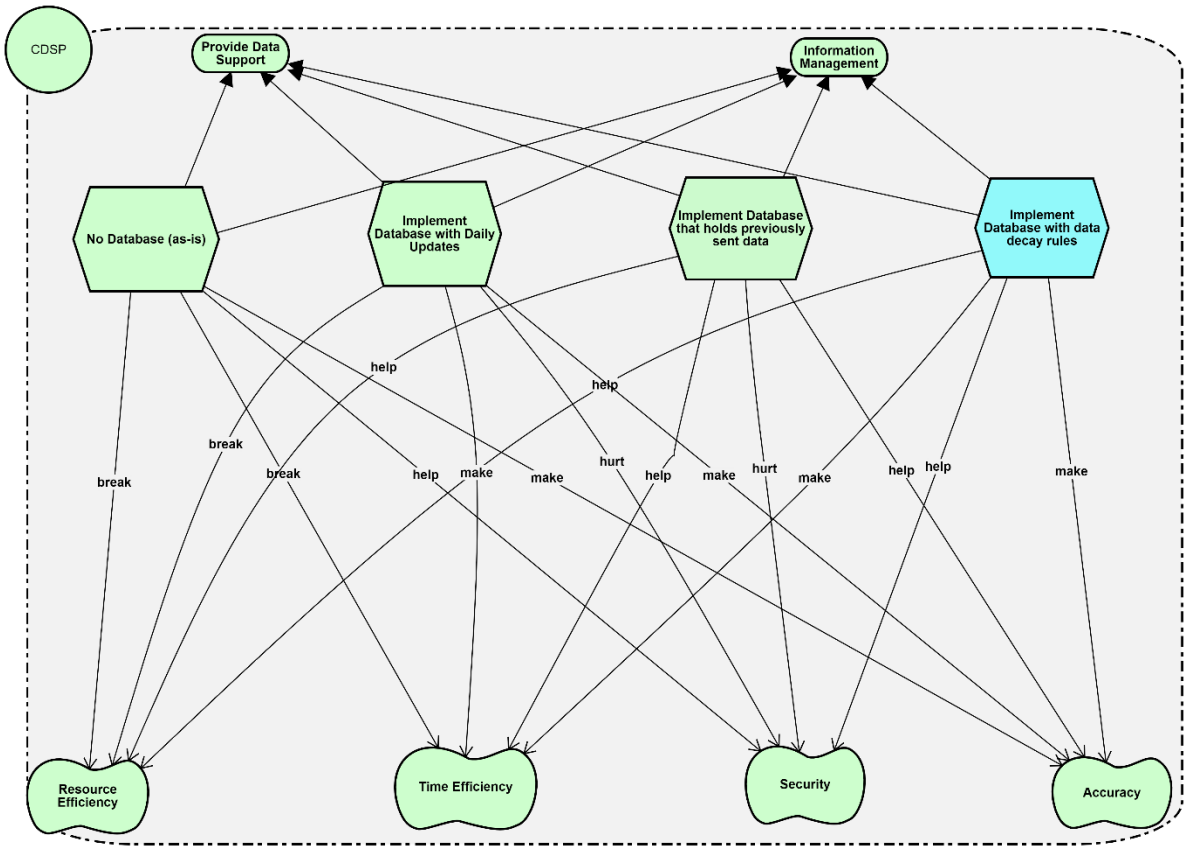

Figure 7: Innovation Alternatives Goal Model

As shown above, our goal model illustrates the main goals of the CDSP, along with four soft goals: time efficiency, accuracy, security and resource efficiency. Although the innovation alternatives were proposed to improve the CDSP's work process, they do not necessarily satisfy all the soft goals identified. This section will analyze how each innovation alternative contributes to the identified soft goals and its limitations.

The first innovation process, implementing a database with daily data updates, improves request response times (time efficiency), and is more accurate compared to a manual process. But storing all the data in the same database can undermine the security soft goal. Although the CDSP has all the data stored in one place, which saves time for staff members to ask for data, they still have to go through the same checking process (such as access rights, crisis authenticity). If some data has been repeatedly requested, the CDSP will still be doing redundant work, thus hurting the resource efficiency soft goal.

The second alternative was to implement a database that holds all previously sent data. This option will also speed up the responding time to requests, helping the time efficiency soft goal. Compared to the first alternative, this database can skip redundant steps for the CDSP if the same data has been requested more than one time by different parties, where it can directly forward the data at the second request, so it also advances the resource efficiency goal. However, as the system holds previously sent data, it has the similar problem with security as the first alternative, thus do not contribute to security.

The third alternative involves a database with data decay rules, which is to have a data expiry date in a given time frame. Like the first two alternatives, this innovation process contributes to the time efficiency soft goal. However, this innovation alternative is the only one the contributes to the security soft goal due to its data decay rules. Since the database can ensure everything that is stored in it is up to date, it saves the time to the CDSP to manually do it, thus it advances the resource efficiency goal as well.

As all three innovation alternatives contribute to the main data delivery goal, selecting a preferred innovation alternative depends on which soft goals the CDSP wants to prioritize. The thing the three innovation alternatives have in common is that they all contribute to the time efficiency goal, which make the CDSP's response time to each request faster. This would leave us with three soft goals: accuracy, security and resource efficiency.

If the CDSP prioritizes security, the third alternative is best. When prioritizing accuracy, the first and third alternative have an equal level of accuracy, because both databases store the most current data. The second and third alternatives help the resource efficiency soft goal if this is prioritized. If security is not a preferred soft goal, either innovation alternative two or three can be selected. Ideally alternative three should be selected because it enhances one additional soft goal. However, the first innovation alternative is unlikely to be selected under any circumstances because although it contributes to the major goal, the process hurts too many soft goals when comparing with the other two.

Comparison of i* and Process Modeling Techniques

Comparison of Techniques in the Context of the Case Study

All three process modeling techniques uncovered different views of the same organization. Advantages of using each technique with respect to the CDSP are outlined below.

Process Modelling Technique	**Pros**	**Cons**
Business Process Modelling (BPMN)	• Captures the control-flow well • Of all the techniques, this best depicted how the organization conceptualizes of its own processes • Quickest of the three models to explain to the organization, as many professionals are familiar with concepts like flow charts and swim lanes • It was easy to understand the process and start asking questions about the data and organizational goals from the BPMN • By revealing points of exchange between pools and tasks that were performed by human actors, it was easier to	• Fails to explicitly identify how improvements to the data request process connect to the strategic objectives of the agencies requesting/providing data • Easy to model changes that appear more efficient but are unviable because they don't address agency soft goals like security • Oversimplified aspects of the process, especially communication flows • Because time intervals are not represented, it is hard to tell at a glance where the biggest time sinks in a process are. Manual processes and waiting for responses took a lot of time

	identify automation and innovation opportunities • Identifies each instance of a process with a start event and an end event (and even intermediate events) allowing for a holistic conceptualization of each instance of the agencies' data request process	in the CDSP's process, but it isn't obvious from the BPMN diagrams • Intentions of the actors based only on the processes are difficult to deduce, which might make some aspects of the BPMN model confusing to someone not familiar with the organization
Data Flow Diagram	• Easy to map out where key pieces of information flow throughout the process • Showed how information is the dominant driver of this whole business process • Raised questions about how data is structured and stored within the organization • Highlighted points where the CDSP would need to think more about their needs when designing a solution. For example, while it was possible in the BPMN to simply refer to a system, data flow modeling encouraged the organization to think more deeply about what data the system would use, process, and output • Made it easy to identify processes that didn't really enrich the data. e.g., the data forwarding step does not actually alter the data, and therefore was a good candidate for elimination	• Specifically, with the CDSP, automation and innovation alternative DFDs became more complicated because diagrams show processes that also happen behind the scenes. • Difficult to articulate how some processes modified data, especially when it came to request validation. Changes were so incremental that in retrospect, the individual verification steps should have been nested under a "validate request" process. • Modeling data flows requires access to personnel who work more closely with the data and can conceptualize those flows. In this case, we did not have access to such persons.
i*	• Introduces the idea of dependencies as vulnerabilities: Both the data provider and requester can view their relationship with the CDSP as a vulnerability • Encouraged actors to consider why they are doing what they are doing, step back from process details and consider deeper change	• Difference between goals and tasks were not always easy to distinguish. The CDSP's role in the current situation is to send and receive data; how to divide this role between tasks and goals was quite challenging and required a deeper analysis of the process itself compared to other modeling techniques

	• Goal modeling made it easier to discern which alternatives might be better for which soft goal prioritization when the alternatives initially seemed very similar in nature	• Since the organization was more used to thinking of tasks and index fields, it was noticeably harder to elicit goals and soft goals. Soft goals were almost always implicit, and we found there was a major goal, information management, beyond that in the CDSP's stated mission.

Strengths and Weaknesses of i* in the General Case

Relative strengths as weaknesses of using i* as a modeling technique are listed in the table below.

Strengths	**Weaknesses**
• Introduces human perspective and emotion to structured and logical systems; can lead better long-term decision making. • Goal-modeling made it clear why certain alternative solutions are preferable to others, even though they may be less cost-effective, take more time, or offer less flexibility. • Goal propagation or viability analysis captures beneficial aspects of certain dependencies. • Modeling strategic dependencies can reveal issues stemming from relationships between actors, rather than from flaws in a single actor's processes. Likewise, they can reveal the limitations of less drastic forms of business process re-engineering (automation and innovation). • Helps materialize importance of organizational goal-setting; If goals of partnering agencies (the vision of individual organizations) are not shared in some way, then the partnership will be weak and may hinder the long-term results of each organization • Helpful for change management. By focusing the reader on organizational goals, it makes radical/transformative change less daunting and more justifiable. With other techniques, it's too easy to focus on the scope of change and not on the reasons for the change.	• Qualitative nature of this modelling language introduces too much variation into how certain processes can be broken down into tasks, goals and soft goals. • Difficult to identify the correct level of abstraction with respect to representing core business processes. Going into more detail may help identify tasks that hurt (soft) goals, but there is a risk of over-emphasizing BPMN/behavior-centric thinking • Not the most readable modelling technique; process looks more complicated at first glance than it actually is, and networks of dependencies quickly become difficult to follow. • It is hard to convey that goals and soft goals can have relative importance • 'And','Or' refinement links cannot be combined: if completing 1 task completes the same goal as completing 2 small tasks does, it is not possible to show, unless the smaller tasks can be grouped hierarchically as part of a larger task. This is not always the case, however. • Contribution links can over-simplify the nature of a contribution, especially when goal modeling. Some tasks, for example, can both help and hinder a soft goal, depending on surrounding circumstances. • Tooling issues: i* modeling is not as well supported as other modeling languages, and existing tools lack basic functionality like an undo feature.

Individual Contributions

Transformation Alternative 1 Group

Abdulaziz Alsinafi: Viability analysis of Alternative 1 (diagram and write-up), process innovation goal model. Contributed to comparison of techniques in the context of the case study. Fact-checking for context and current state; point person for the CDSP; editing.

Adanna Chigbo: Came up with Transformation 1; drafted an i* diagram for Transformation 1; wrote up transformation description and contributed to analysis of the alternatives (devil's quadrangle-based evaluation for the As-Is situation and Transformation 1); contributed to the comparison of techniques; and did the bibliography.

Yadi He: Drafted the executive summary, wrote descriptions and analysis for process innovation alternatives. Did some editing for the overall content and contributed to the modeling techniques table.

Transformation Alternative 2 Group

Benyamin Behzad: Drafted descriptions of process automation alternatives and automation goal model analysis write-up.

Faria Khandaker: Edited executive summary; wrote context; cowrote as-is write up; brainstormed Transformation 2 with A; created Transformation 2 viability analysis diagram and wrote viability analysis write up; created automation goal model; created pros and cons table for transformation alternatives one and two and wrote comparison of alternatives write up; helped write comparison of i* and process modelling techniques section; project coordination.

A Mahfouz: Created As-Is, and Transformation 2 i* diagrams; re-did Transformation 1 diagram based on Adanna’s drafts and write-up. Co-wrote As-Is write up, brainstormed Transformation 2 with Faria, wrote Transformation 2 description. Contributed to comparison of to-be alternatives. Edited automation descriptions; re-did automation goal model analysis write-up. Contributed to the comparison of i* and process modelling techniques section. Editing and formatting.

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