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A Levels, Readiness, and Impact Evaluation Model for GS1 Adoption in Healthcare

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Abstract

The use of GS1 data standards is envisioned to improve the efficiency of healthcare supply chain, as it did for retail. Care providers willing to adopt such a strategy in some or all of their operations often need to invest in process changes and technological installations or upgrades; however, they struggle to project returns on those investments and hence, find uncertain ROI a barrier to adoption. We present a hierarchical comprehensive model that helps potential adopters of various parts of the standards (what we term levels) evaluate their readiness requirements and quantify the impacts of their potential decisions in terms of non-monetary performance measures, such as productivity. The model design is showcased through practical examples.

Keywords
Healthcare, data standards, GS1, return on investment, decision making

1. Introduction
The GS1 system of global data standards is emerging as the long needed approach to gaining the efficiencies widely seen in other industries that grow from using unambiguous, universally accepted identifiers for products and partners/locations. Widespread adoption of all or part of the GS1 system by the thousands of hospital providers is essential to making the standards the true common language of the healthcare supply chain industry. Still, most potential adopters are hesitant and confused about whether and how to adopt because they lack understanding of the associated returns on investment (ROI). What process changes and system enhancements will be required, and what benefits can they be expected to produce?

ROI in the context of GS1 standards is complicated to assess because there is limited actual experience on which to draw, and each provider brings different scales and scopes of operations, as well as different supporting information systems and partnership arrangements with manufacturers, distributors, and group purchasing organizations (GPOs). In addition, GS1 adoption is far from an all-or-nothing choice. Different levels of adoption may be implemented and produce value without the rest. Also, the standards may be adopted in all or just parts of a hospital's supply chain operations. (See also references [1-4].)

The Center for Innovation in Healthcare Logistics (CIHL) at the University of Arkansas, which is an industry-university partnership to identify and foster system-wide adoption of ground-breaking healthcare supply chain and logistic innovations, has been engaged with a number of industry partners and provider sites over the past two years in a Data Standards implementation project to understand the costs, barriers and opportunities providers can expect in GS1 standards adoption. This paper provides an overview of CIHL's emerging *Levels, Readiness and Impacts Model (LRIM)* designed to provide a user-friendly (Excel-based) spreadsheet tool helping providers meet their need to quantify the investments and benefits they can expect from GS1 adoption choices. LRIM does not attempt to estimate dollar costs and benefits. Instead, the model aims to provide quantitative foundations on which those economic assessments can be constructed for particular provider settings.

2. LRIM Architecture

LRIM is based on a hierarchical infrastructure (depicted in Figure 1) that comprises six main components, each of which is discussed with more details in the upcoming sections. These elements consist of: (1) the *levels of GS1 applications* that the healthcare provider may opt to implement, (2) the technological and logistical *readiness* requirements needed for the selected applications implementation, (3) the *shortfalls* that result from not meeting the necessary requirements, (4) the *drivers* that enable certain improvements in the system, (5) the *process metrics* that help model the healthcare provider's logistical system, and (6) the *impacts* that result from selecting specific GS1 applications. The arrows in Figure 1 depict the flow of the decisions impacts (that start from the root); this yields the ability of triggering the appropriate elements within a category and extract output values that are used in the group that follows.

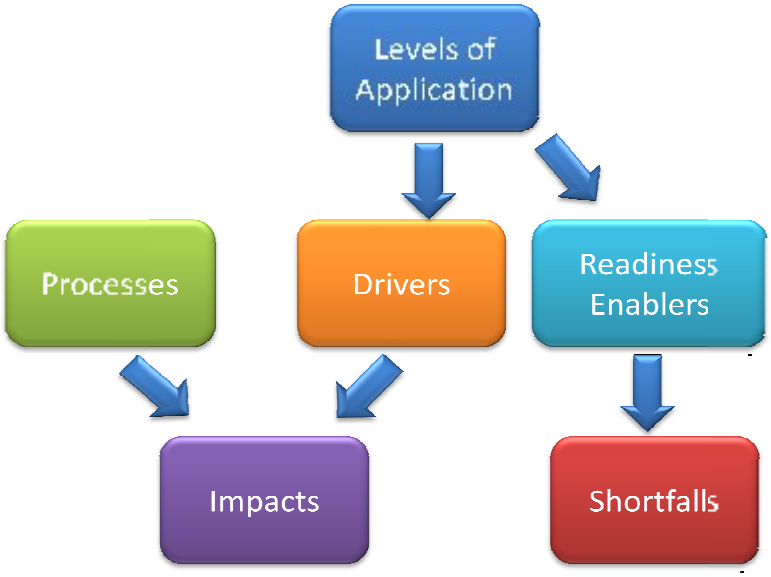

Figure 1. General Design of LRIM

3. Levels of Application

As its name implies, the LRIM model begins with the choice of how much or what *level* of the GS1 system to implement and what parts of the hospitals supply operations to include. Standards center around Global Location Numbers (GLNs) identifying supply chain partners and locations, and Global Trade Identification Numbers (GTINs) identifying products down to the level of unit of measure. A global GLN registry is maintained by GS1 for GLNs, and a Global Data Synchronization Network (GDSN) indexes GTINs.

CIHL has identified three major levels of possible provider adoption of the standards elements, with a total of 11 sublevels (see Figure 2). Broadly, Level 1 involves use of GLNs and GTINs in hospital supply chain databases and transactions of both the external order/pay cycle and internal inventory/materials management – all without tracking barcodes or other automatic identification technology. Level 2 adds the use of those technologies (typically barcodes) to take advantage of scanable GTINs on product or storage-shelf labels. Finally, Level 3 extends the use of GTIN identifiers to the point of patient care and exploits *secondary data* like expiration dates and lot/serial numbers on products to facilitate efficient recall, return, and outdate management

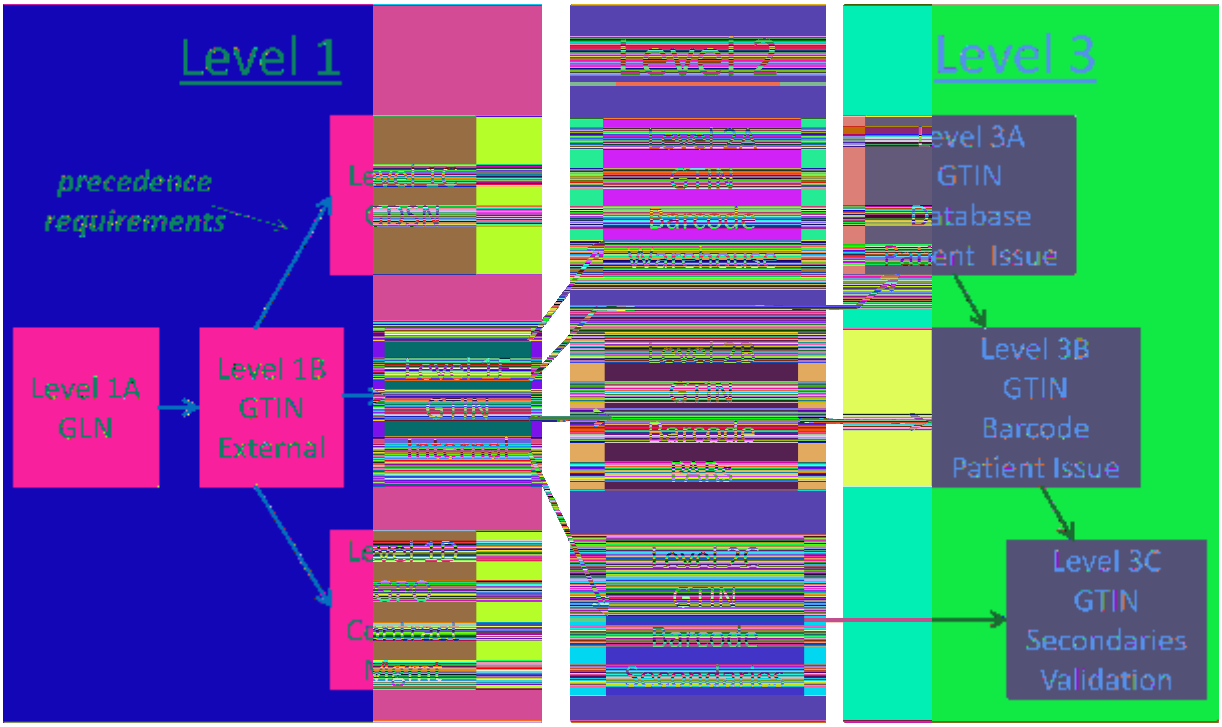

Figure 2. GS1 Application Levels

Arrows in Figure 2 depict precedence requirements between application sublevels. For example, implementation of GTIN barcode processing in only nursing par-units (Level 2B) requires GLN and GTIN internal and external adoption in transactions and databases (Levels 1A, 1C and 1E). However, full integration with the GDSN (Level 1B) or GPO contract management (Level 1D) may or may not be included. The same is true for other elements of Levels 2 and 3.

4. Readiness: Enablers and Shortfalls

The overall design of LRIM depicted in Figure 1 shows that all analysis begins with users selecting application sublevel(s) in Figure 2 to be considered for implementation. The next step is to detail the *readiness* requirements—including process changes, database cleanup, information technology investments, etc.—that would be needed for implementation of the selected application level(s).

Table 1 provides a complete list of current LRIM readiness *enablers* needed for at least one sublevel. It also indicates those specifically required for two examples of sublevel choices—Level 1E: GTIN Internal Implementation, and Level 3B: GTIN Barcode Patient Issue—including their respective prerequisites.

Table 1. Readiness Enablers

No.	Name	Level 1E	Level 3B
1	GLNs registered and responsibility assigned within provider	√	√
2	GLNs are cross-reconciled with distributors, suppliers	√	√
3	MMIS supports GLN-anchored location identifiers	√	√
4	EDI supports GLN-anchored location identifiers	√	√
5	MMIS supports GTIN-anchored processing in multiple units of measure	√	√
6	GTINs are cross-reconciled with distributors and suppliers	√	√
7	EDI supports GTIN-anchored numbers	√	√
8	Downloadable data-pools are available for GTIN-anchored item identifiers		
9	Data-import tools are available for MMIS database and GDSN synchronization		
10	GPO contracts are tracked by GLN- and GTIN-anchored identifiers		
11	GLNs are cross-reconciled with GPO's		

12	GTINs are cross-reconciled with GPO's		
13	Distributors and manufacturers support sales-tracing by GLN-anchored identifiers		
14	Distributors and manufacturers support sales-tracing by GTIN-anchored identifiers		
15	MMIS and adjunct software support GTIN-anchored internal inventory processes	√	√
16	MMIS and adjunct software support barcode-driven warehouse inventory processes		
17	GTIN-based barcodes are available on product-labels or bin-locations at the warehouse		
18	MMIS and adjunct software support barcode-driven internal inventory par-units processes		√
19	GTIN-based barcodes are available on product-labels or bin-locations at the par-units		√
20	MMIS and adjunct software support barcode-driven tracking of secondary data		
21	Patient billing software supports GTIN-anchored charge transactions		√
22	Patient stock-issue software (e.g. MMIS, clinical) supports GTIN-anchored inventory transactions		√
23	Clinical software supports orders and clinical records anchored by GTINs		√
24	Patient stock-issue software (e.g. MMIS, clinical) supports barcode-driven inventory transactions		√
25	Clinical software supports barcode-verified clinical records anchored by GTINs		√
26	Software supports barcode-driven tracking and verification of secondary data at point of care		

Some of the enablers relate to databases of supply chain partners. For example, Enabler 2 requires provider GLN synchronization with supplier and distributor information systems. Others enablers address information system needs. Examples are number 3 requiring support of GLNs in the provider's Materials Management Information System (MMIS), and number 16 adding support for GTIN barcode processing in internal inventory management. Still, other enablers (e.g. numbers 1 and 10) demand process changes in order to utilize the various elements of the GS1 system.

It is important to recognize the readiness does not necessarily require direct use of 13-digit GLNs or 14-digit GTINs in implemented processes. The lengths and random formats of those identifiers are not convenient for human use, and organizations are often reluctant to give up substantial investments in legacy numbering. Instead, LRIM presumes that corresponding identifiers be *GLN*- or *GTIN-anchored*. That is, the GS1 standards should be tracked in databases and transactions, with cross-reference to legacy identifiers. Although legacy numbers may be used in many processes, GLNs and GTINs anchor the cross-reference as the ultimate sources of truth, and other identifiers must be kept in synch with their GS1 analogs.

As shown by the two examples in Table 1, the enablers required for a specific implementation can vary widely. Still, all those needed must be addressed for a satisfactory adoption. Any *shortfalls* that may be noted will require investment on the part of the provider. LRIM does not compute dollar value of those investments because circumstances vary so significantly among specific provider sites (e.g. regarding the current version of their MMIS software). Still, the list of shortfall items provides a starting point for users to calculate investment cost at their site.

5. Impact Drivers

The more challenging part of cost and benefit analysis is to predict quantitative impacts from implementation of different sublevels of applications. A major innovation of the LRIM design is to begin this analysis by identifying high-level *drivers* of application impacts. What do various application levels actually do to affect processes? In LRIM, drivers are triggered by one or more selected applications (e.g. the application "GLN Implementation" activates the driver "Improved Partner Identification"). Once triggered, a driver contributes to impacting the internal systems of the healthcare provider by influencing a set of process metrics (explained in Section 6).

Table 2 lists the drivers included in the present version of LRIM, and like Table 1, also picks out those activated by example application sublevels 1E and 3B, as well as their predecessors.

Table 2. Impact Drivers

No.	List of Impact Drivers	Level 1E	Level 3B
1	Improved partner identification (right partner)	√	√
2	Improved partner data synchronization	√	√
3	Improved GPO partner identification		
4	Improved GPO rostering synchronization		
5	Improved item identification (right product) internally	√	√
6	Improved item identification (right product) externally	√	√
7	Improved item data synchronization (non-price)		

8	Improved item price data synchronization		
9	Improved price contract synchronization		
10	Improved item identification efficiency (automation) in the warehouse		
11	Improved item identification efficiency (automation) at the par-units		√
12	Improved validation against outdated and recalled items		
13	Improved patient-billable item identification		√
14	Improved efficiency of patient billing (automation)		√
15	Improved internal information system interoperability	√	√
16	Improved sales tracing synchronization		
17	Improved efficiency of outdates, returns, and recalls management		
18	Improved patient order item identification		√
19	Improved patient order item identification efficiency (automation)		√
20	Improved efficiency of the search of the patients affected by recalls		

Driver number 2 illustrates that improved customer data synchronization should result from sublevel 1E or its predecessors. Similarly, Drivers 5 and 6 indicate the gains expected in correct item identification from sublevels empowering them.

6. Supply Chain Processes

As illustrated below, LRIM computes expected GS1 impacts in a hospital supply chain by *process*. Although variations do arise among different providers, CIHL investigations have found a remarkable similarity regarding which processes make up provider supply chain operations (although their details vary considerably). Table 3 gives a complete list of those treated in the current version of LRIM.

Table 3. Provider Supply Chain Processes

No.	**Name**
1	Ordering
2	Receiving
3	Putaway
4	Picking
5	Par-unit replenishment
6	Stock-issue
7	Cart-count
8	Invoice reconciliation
9	Pricing and contract management
10	Item-File-Master maintenance
11	Location-Master-File maintenance
12	Point-of-care validation
13	Find and return items
14	Find and alert patient

The areas where it has proved important to reach deeper in classifying processes are those involving inventory management in clinical par-units and issue of materials for patient use. LRIM addresses these concerns by considering clinical units as mixes of the three different technology categories shown in Figure 3.

(a) Manual

(b) Semi-Automated

(c) Automated

Figure 3. Technology Classifications within Clinical Units

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7. Process Metrics and Computations

Empowered by application-level choices and the enumeration of implied impact drivers, LRIM computations are performed process by process. As illustrated in Figure 4, a series of variable values describing the current state of user supply chain operations are first input to process computations. GS1-generated drivers transform appropriate variables within that input set to compute output values projected after standards implementation using driver *impact factors* estimated from CIHL and other experience together with expert opinions. Those outputs—or aggregations of them—lead to the projected quantitative impacts.

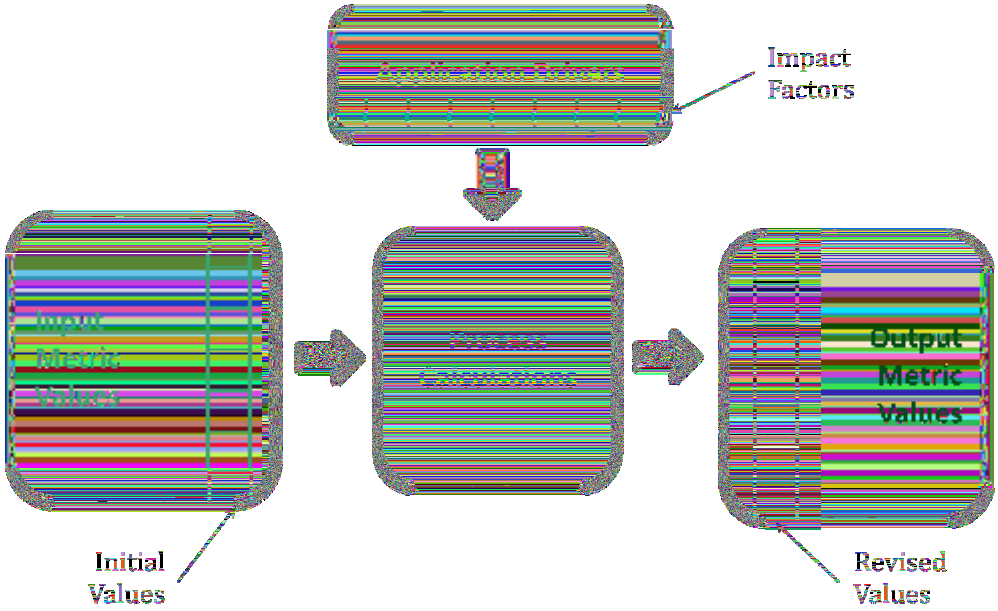

Figure 4. Process of Variables Computation

Variables of interest depend in part on what processes are impacted by the chosen sublevel of GS1 application. Three major categories proved to be needed: variables related to *errors*, ones related to the *scale* of process operations, and those specifying the numbers of *personnel* committed to various process tasks. (Mixes of technologies shown in Figure 3 also become relevant for some processes.) Tables 4, 5 and 6 list some of the variables in use within each main category in the current version of LRIM.

Table 4. Example Variables Related to Errors

1	% errors produced during ordering
2	% errors produced during receiving
3	% errors produced during stock-issue through a manual process
4	% errors produced during stock-issue through a semi-automatic process
5	% errors produced during stock-issue through an automatic process
6	% errors produced during patient billing
7	% errors produced during invoice reconciliation
8	% errors produced during membership-registry maintenance
9	% errors produced during active-items pricing
10	# of location-based exceptions (average per month)

Table 5. Example Variables Related to Scale

1	# of EDI PO lines (including the do-overs)
2	% stock-issue lines patient billable
3	% stock-issue lines goes into clinical records
4	% of par SKUs handled through a manual process
5	% of par SKUs handled through a semi-automatic process
6	% of par SKUs handled through an automatic process

Table 6. Example Variables Related to Personnel

1	# of FTEs involved in ordering
2	# of FTEs involved in picking
3	# of FTEs (clinical) involved in cart-count
4	# of FTEs (material handling) involved in cart-count through a manual process
5	# of FTEs involved in item-master-file maintenance
6	# of FTEs (clinical) involved in stock issue/BPOC (using all types of technologies)
7	# of FTEs involved in location-master-file maintenance

Details of variable updates vary, but the main idea employed can be illustrated with a simple example. In the Cart-Count process, let input variable p^{input}= 4.0 be the number of FTEs currently required. Also, assume two impact drivers d_5 and d_{11} from Table 2 are applicable, and they are expected to improve productivity by impact factors f_5 = 0.20 and f_{11} = 0.35. Here f_5 is due to reducing processing volume by avoiding do-overs and f_{11} is due to increased productivity with barcode automation. Then computations would project $p^{output} = p^{input}$ (1 - f_5)(1 - f_{11}) = 2.08 FTEs with a reduction of 2.08 FTEs for the Cart-Count process due to the selected level of GS1 application. Subsequent computation might sum personnel savings across the entire supply chain to predict the overall provider impact.

As with required investments, LRIM does not translate such estimated impacts into dollar gains because details of provider operations vary widely. However, model results do provide a quantitative foundation on which to base dollar savings computations at particular sites.

8. Conclusion and Future Development Plans

This paper presents an Excel-based decision tool (called LRIM) that enumerates the readiness requirements and simulates impacts of GS1 standards adoption based upon the choices of GS1 applications and user-specific system metrics. It uses a deterministic model to establish relationships between GS1 applications and metrics of healthcare supply chain processes through the concept of *drivers*. Upon their activation, these drivers enable projections of numerically anticipated improvements in process and system variables, mainly ones representing productivity and error rates. When broadly available, LRIM will give providers both the ability to rapidly explore alternative adoption paths they might pursue, and a quantitative foundation for more complete economic assessments of chosen options.

This tool, which is currently a developmental prototype, will be made publically available online once refinement is complete. Many of the details of the LRIM system remain under analysis and development. The CIHL data standards team is continuing refinements with a goal of demonstrating a realistic, full-scale case example in the coming months.

Acknowledgements

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