Achieving Knowledge Translation for Technology Transfer: Implications for Evaluation[1]

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Research programs implementing public policies through information or product innovations are held accountable for evidence of societal impact. In response, evaluation tools such as PART and the logic model have been used for program reviews and program planning. Program managers in areas such as healthcare are seeking to demonstrate research impact through knowledge translation. This paper presents an evaluation framework for the special case of knowledge translation for technology transfer (KT4TT), to guide research project managers to plan for successful innovations. While logic models help research programs to plan for needed results, individual projects funded under them must provide credible and relevant data by framing research questions based on explicit connections between planned impacts and user needs. We propose integrating the CIPP model into the logic model so relevance is proactively ensured. By also ensuring quality through formative and summative evaluations, the CIPP model is a fitting complement to the logic model.

Introduction

Achieving societal impact through evidence based practice and policy making is an issue that has received increasing attention by social scientists over the last century. The need to influence decisions using evidence from research, initially pointed out and discussed by Weiss (1979) as *research utilization*, has since been discussed under varying terminology including *knowledge utilization, knowledge transfer, knowledge dissemination, and knowledge exchange* (International Development Research Centre, Ca. *online, retrieved* Sep. 2007). This need is currently addressed as an issue of *knowledge translation* (KT) by several fields of research application, health care being in the forefront. The concern is about impacting the ultimate beneficiaries i.e., the intended end users of knowledge; and the challenge is about

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communicating research-generated evidence in accessible and usable forms to potential users and ensuring it is used. Different stakeholders, including policy makers and researchers, have responded to the challenge in different ways. Attempts by the federal government to improve results of funding programs (Averch, 2004) have included legislative measures such as the Government Performance Results Act (GPRA) in 1993 and measurement tools such as Program Assessment Rating Tools (PART) by the US office of Management and Budget (OMB). Funders of research, on the other hand, have responded with the use of planning and management tools such as the *logic model* (Wholey, 1987, 2004; McLaughlin and Jordan, 1991, 2004) to guide the projects they sponsor and the data they collect for accountability. Alongside a concern for quantitative increase in research use, Research syntheses, Meta analyses and Systematic Reviews (Boruch and Petrosino, 2004) have focused on the quality of the evidence itself and addressed the issue of qualitative improvement in research use. Quite understandably however, such efforts have heavily concentrated on past research, either looking for and measuring effects from them or assessing the credibility of the evidence they generate for worthiness of use. An urgent and equally significant need in KT is a focus on future research and its use.

In light of the foregoing, this paper attempts the development of an evaluation framework for KT, that addresses planning for and obtaining research outputs for success i.e., beneficial impact on users. For the purposes of this work we focus on the specific case of translating *technological* outputs, i.e., KT for Technology Transfer (KT4TT), although the rationale may apply for KT in general. The framework defends the argument that in obtaining impact from research, the issue is not so much how to track and measure it as it is how to plan for it and obtain it. While rigor of research is indispensable for the credibility of the evidence it generates, relevance is an equally

indispensable aspect and should be built into the evidence. Evaluation plays a crucial role in this effort, which is often overlooked. Projects do not engage evaluation optimally from beginning to end, but tend to view it as most important for the tracking/measuring phase. Arguing that the optimal use of evaluation brings relevance to research projects, we use an integration of the CIPP model (Stufflebeam et al, 1973; 2001; 2007) with the earlier mentioned Logic Model leading to an evaluation framework that can support planning of relevant research as well as tracking its impacts. A case is made for a *situation analysis* by the funding program as a basis for funding, and for a *context evaluation* by the funded projects to steer research towards relevance.

Knowledge Translation: Current concepts

As explained above, the need for KT stems from a concern about the current under-utilization of knowledge accumulated from research. The concept of KT as a solution involves a strategic communication of research findings to those interested in using them, resulting in their use of the evidence.

Definitions:

The most commonly used definition of KT according to literature is the one by the Canadian Institutes of Health Research (CIHR) which is: *"Knowledge translation is a dynamic and iterative process that includes synthesis, dissemination, exchange and ethically sound application of knowledge to improve the health of [citizens], provide more effective health services and products and strengthen the health care system"*. (CIHR. http://www.cihr-irsc.gc.ca/e/29418.html)

Models:

Among the many efforts to develop models of KT (Sudsawad, 2004), the Knowledge-to-Action (KTA) model by Graham and colleagues (Graham et al, 2006) is notable for its comprehensive inclusion of the

involved aspects. It incorporates both a *knowledge creation* component and a corresponding *Action Cycle* component that should promote the use of this knowledge. The creation component takes knowledge from the *inquiry* stage to the *tools* stage; while the Action Cycle proposes to identify and address problems relevant to the application of these tools. Further, it recognizes the importance of adapting the knowledge to the context of application.

Implementing KT:

Two key concepts currently in use while implementing the KTA model refer to *end-of-grant KT and integrated KT*. As the terms indicate, *end of grant KT* focuses on translating research outputs from projects that have completed their grant cycle or funding period; while *integrated KT* addresses the issue starting at the very beginning of the research project. Both concepts recognize the need to translate research that has been funded and expected to succeed. These are important steps for research use and can hardly be ignored from an accountability viewpoint.

Relevance Vs. Rigor in knowledge creation:

At the same time, it is important to recognize that among the many barriers to research use is the motivation of the user to adopt them. Getting intended users' interest and effort in applying the knowledge might well be a heavier burden on KT than it would seem at first. In fact, resistance to change and to adopt innovations is the key problem addressed in diffusion literature (Rogers, 2003). It stands to reason that a person or organization assessing knowledge for use would derive appeal from its potential utility or relevance as much as from its quality. While merit and worth (Joint Committee, 1994) are both important aspects of research evidence, merit without worth is less likely to be adopted. In light of this, it would seem highly important to focus a KT effort on research well before its conceptualization, and pro-actively direct it towards outputs that are relevant to user contexts and therefore likely to be applied by them. This does not assume that uptake and use of knowledge becomes automatic, nor does it eliminate

the need for a strategic and systematic KT. This leads us to take a closer look at the KT process and to appreciate the challenges of taking research to its intended beneficiaries.

What is involved in the KT process?

For purposes of KT, the flow of knowledge can be thought of as following a hypothetical path summarized in Table 1. Findings from research typically released as a published article, may be directly and immediately usable by other interested researchers; but almost never reach the intended beneficiaries (patients for a new drug concept, for example) directly. The knowledge or *evidence based concept* almost always goes through intermediaries who act on it or change it some way so it is accessible and usable by the end user. As an example, the concept for an innovative wheelchair or a breakthrough drug typically goes through a manufacturer for prototyping, testing, producing and marketing, then through health professionals who prescribe it, and through insurance companies who make reimbursement policies – before the end user benefits from the drug or the new wheelchair. These intermediaries change their own practice or policy in some way in transforming and improving the knowledge; thus they are important stakeholders of the research generated knowledge. In making KT happen, we therefore need to ensure that the immediate results from research be first uptaken by these intermediary stakeholders. These short term and midterm changes must occur before knowledge reaches end-users and brings them long term benefits. Put in another way, the flow of knowledge in KT involves taking the *outputs* from research first to the intermediate stakeholders for their uptake and use. This constitutes an *outcome* or change in the short and midterms. Practice changes, policy changes and products in the marketplace are all outcomes necessary before *impacts* on beneficiaries are a reality. Summing up, the flow of KT involves a flow of outputs to impacts

through outcomes. KT is the strategic communication of outputs to stakeholders for outcomes resulting in impacts for end users.

Table 1. The Path of KT

Knowledge	→	**Intermediaries**	→	**End Users**
Research	→	**Intermediate Stakeholders**	→	**Beneficiaries**
Immediate Results	→	**Short term/midterm changes [in user context]**	→	**Long term benefits [to users]**
Outputs	→	**Outcomes**	→	**Impacts**

What is Knowledge Translation for Technology Transfer (KT4TT)?

As discussed above, KT implies taking research outputs to impacts on end users via outcomes that involve intermediaries. Technology transfer implies that research aims for technological outputs, and KT takes on a special path. Thus, we can think of KT4TT as the strategic communication of *technological* outputs from research to stakeholders for outcomes that impact intended users.

Implications for KT:

What is the path for KT where technological outputs are involved? The difference in this case is that research outputs are tangible, as opposed to tacit knowledge generally resulting from basic research. The discoveries or conceptual outputs go through a couple of more steps in taking on a tangible form; first through invention (prototype form) and then through innovation (product launched in market). There is, in a sense, an *output chain* instead of one output that becomes the

focus of KT. Correspondingly, there are three processes involved – research (R) for conceptual output, development (D) for prototype output and production (P) for product output.

Implications for tracking research impacts:

In effect, the involvement of R-D-P processes in KT4TT means an R-D-P project; as opposed to just an R project. Understandably, tracking impacts can become problematic if sponsors funding such "research" treat them as R projects while expecting results of R-D-P projects, for accountability purposes. It thus becomes important that both sponsors and the funded projects have this clarity and treat the R-D-P process explicitly.

Sub-optimal use of evaluation:

It is also important to recognize that the issue in accountability of funded research is not so much about tracking of the impact generated as it is about planning for and obtaining such impact. We reiterate that both credibility (merit) and relevance (worth) of the knowledge are equally important for KT efforts; and it includes KT4TT efforts. We reiterate, also, that evaluation can play a significant role in building both merit and worth into projects. This role however is still not as widely recognized by funders and funded projects as it should be - which makes evaluation's use sub-optimal.

Achieving merit and worth in outputs: the CIPP model of evaluation:

Figure 1 describes the role of evaluation in project management using a slightly modified version of the CIPP (Context, Input, Process and Product) evaluation model proposed by Stufflebeam (Stufflebeam et al, 1973; Stufflebeam and Shinkfield, 1985; 2007; Stufflebeam, 2001). It shows how evaluative information enlightens four major decisions of a project manager. *Context*

evaluation supplies information about the needs of target beneficiaries thus guiding project goals; *input evaluation* helps to put the project together through information about needed and available resources. When the project process goes into implementation, *process evaluation* helps to find the optimal process for getting the intended output. *Product or Output evaluation* assesses the output first formatively while it is taking shape; it then assesses it summatively at the end to verify and document that the output meets the intended quality criteria (Scriven, 1973, 1991). In summary, context evaluation lends direction to the project, taking it closer to the target audience needs; it brings relevance (worth) to the project and its planned output. Input evaluation ensures that the project is feasible. Process evaluation helps to make the project efficient. Finally, product or output evaluation both ensures and assesses the quality (merit) of the output. Thus, evaluation builds relevance from the beginning. It also builds quality by repeated assessment during formative evaluation. Systematic evaluation done according to the CIPP brings both merit and relevance to the project output.

Evaluation and the R-D-P Process: the KT4TT management model

By extension the CIPP model of evaluation can be applied to an R-D-P project, in effect guiding the KT4TT process. Figure 2 outlines graphically the role of evaluation in an R-D-P project. It is a flowchart version of the KT4TT management model developed by Lane and Flagg (2009), a full description of which is presented on the website of the KT4TT Center (http://kt4tt.buffalo.edu/knowledgebase/model.php).

This is a *stage-gate* model that is an adapted version of the PDMA (Product Development Management Association) model (Kahn, Castellion and Griffin, 2005). The process is conceptualized to proceed in stages. The project movement from one stage to the next is controlled by decision gates, making it conditional to satisfactory completion of the stage in

relation to goal/output achievement. What enlightens the decision at the gates is systematic evaluation; it enables the forward movement across the gates by supplying the needed evaluative information. As the flowchart indicates, several key implications follow from the interaction of evaluation with the process stages and decision gates.

- Stages 1 and 2 define project goal – which is the final P output, not just the R output. Evaluation supplies beneficiary needs. So, KT4TT starts *before* conceptualizing the R process.
- Stage 3 performs research and yields the discovery output. Stages 4, 5 and 6 conduct the development and lead to the prototype. Stages 7, 8 and 9 make the product from the prototype, do the launch and follow its market performance.
- The R-D-P process is continuous but can be completed as separate projects. Projects can start at D if prior new knowledge is available; or at P with a prior prototype. Or, each project can stop at its output. However, the relevance of the final output or innovation is built from the beginning, no matter which part of the R-D-P is being implemented.
- Manufacturer is a key stakeholder in taking R to D and P.

Getting Outcomes and Impacts from R-D-P project outputs

As seen above, evaluation builds relevance into the final output and also guides the quality of the output through the R-D-P process. How does evaluation help in tracking the impact of this output?

Role of the CIPP model:

The CIPP's role in shaping the output is very explicit and clear, but its role beyond the output in tracking the outcome and impact is not so explicit. The R-D-P projects need additional guidance. The logic model is often used by the sponsoring agencies to provide such guidance (United Way of America, 1996; W.K. Kellogg Foundation, 2001).

Role of the Logic Model:

A basic version of the logic model used by some funders is presented in Figure 3. It shows a flow of project operations from input to activities to output. It also shows outputs generating outcomes in the short term and midterm; these are outcomes or changes in the intermediaries. Manufacturer practices, health professional practices, policy changes are all examples. At the end, long term benefits expected by the agency should occur. An example would be "increased functional independence of consumers with disabilities through the use of assistive technology", which is a goal of NIDRR (National Institute for Disability and Rehabilitation Research). As for KT, its more obvious role is expected to occur from the output stage on, when the outputs are disseminated for uptake and use by stakeholders.

Outcome and impact evaluations are an important part in the logic model, shown in their most obvious role for accountability. It is also the funding agency's data source for overall accountability.

Integrating CIPP with the Logic Model:

As one can see, neither the CIPP model nor the logic model alone gives a complete picture of the interactions of the R-D-P process with its outputs and their bridge to outcomes and impacts. With

CIPP, KT starts as early as the actual conception of the project activities, and provides relevance through context evaluation. With the logic model, the relevant output is carried further through KT and leads to relevant outcomes and beneficial impacts. It would make sense to consider an integration of the two models as a useful evaluation framework for R-D-P project managers, as it would describe the complete role of evaluation from building relevance to tracking impacts. Figures 4, 5 and 6 present this integration.

An Evaluation Framework for Achieving and Assessing Impacts from R-D-P Projects:

Figure 4 shows the logic model with:

- The superposition of the Context, Input, Process and Product evaluations around the project activities box;
- The activities box expanded to show the R-D-P relations;
- The KT bridges that link R, D, and P outputs; note the initial gate before R, which eliminates the need for R if new knowledge already exists. Note the forked KT symbols from the outputs to outcomes. Here KT happens in two ways: a general KT and a more focused KT. The first case involves disseminating outputs to all interested stakeholders such as clinicians, other researchers, practitioners, policymakers and brokers (use facilitators). In the second case, KT can occur on a specific level by taking an R/D/P output forward by actually partnering with a manufacturer, for example. This would be a focused KT.

Figure 5 expands the logic model further. It shows one half of the model in which outcomes are progressing towards impact. Note how the R outputs are slower to reach the impact stage and are lagging behind D and P outputs that have a head start. Research impact is thus a matter of time

but not of probability, and will likely not happen within the period of funding as expected for accountability purposes.

Figure 6 shows the complete framework expanding both halves of the logic model in which the bridging role of KT as well as evaluation's role from beginning to end is shown.

A significant message from the integrated evaluation framework is the importance of context evaluation at the start of the funded project. It intersects, on a broader funder level, with the overall program's own context evaluation, in effect a *situation analysis*. Just as context evaluation provides the information necessary for defining project objectives, situation analysis should help define the funding priorities and request for proposals. The priorities themselves will thus be *evidence based*. It can be useful to the funding agency in assessing grant proposals for relevance, defining indicators of impact and determining the data to be collected from projects. Further, they will have a leading role in guiding projects' needs analyses, and ensuring they are not divorced from funding priorities.

On another level, context evaluation is significant for the funded project. It is the point of intersection with the funding program. It is also its link to the beneficiary's needs, a condition necessary to ensure relevance of project outputs. Thus, it is aligned both with the end users' needs and with the funder priorities.

Summing up, beginning right is a big part of achieving impact.

Final considerations:

Recognizing that impact generation is a collective effort between the funder programs and the funded projects, this paper proposes an evaluation framework with a twofold purpose: to provide

a tool for program managers to solicit, fund and facilitate impact-oriented research projects; and to guide the funded projects to plan for successful innovations and to feed credible and relevant impact data back to the program. In presenting and discussing the framework, the paper focused on the special case of technological innovations, addressing knowledge translation for technology transfer (KT4TT).

The proposed framework is basically an integration of the CIPP (*context, input, process and product*) evaluation model into the Program Logic model. What links the two models is the *context evaluation* of the funded project, embedded in the *situation analysis* of the funder's broader context, aligning both funder goals and project objectives with anticipated end user benefits – a basic condition for ensuring relevance of project outputs. With evaluation's continued role through the project the relevance is carried through into the outputs, and further tracked through follow up assessment and delivered to funders and other stakeholders.

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Figure 1. Evaluation enlightens decision-making (Adapted from Stufflebeam et al, 1971)

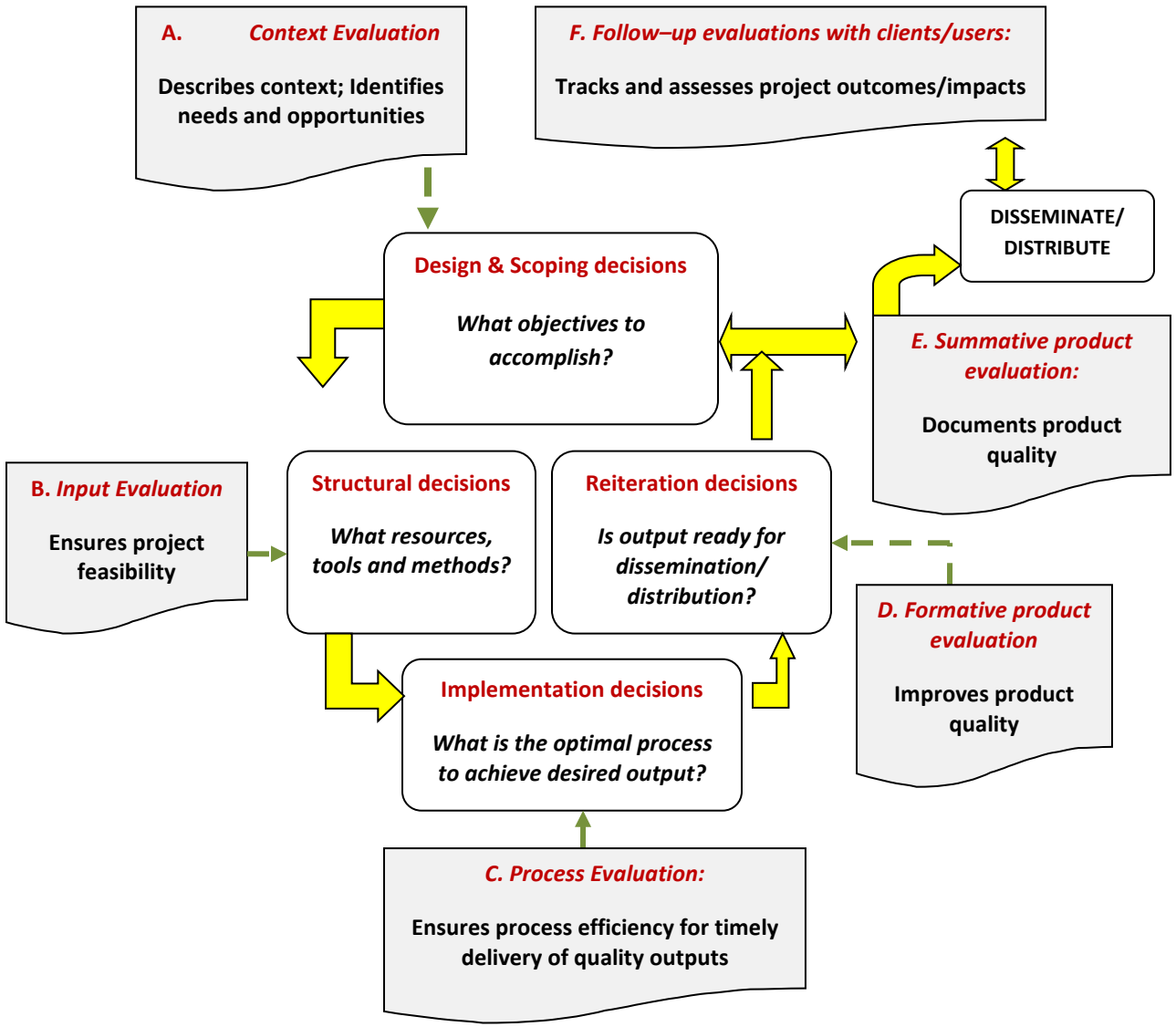

Figure 3. Implications of KT for the Logic Model: A simple version

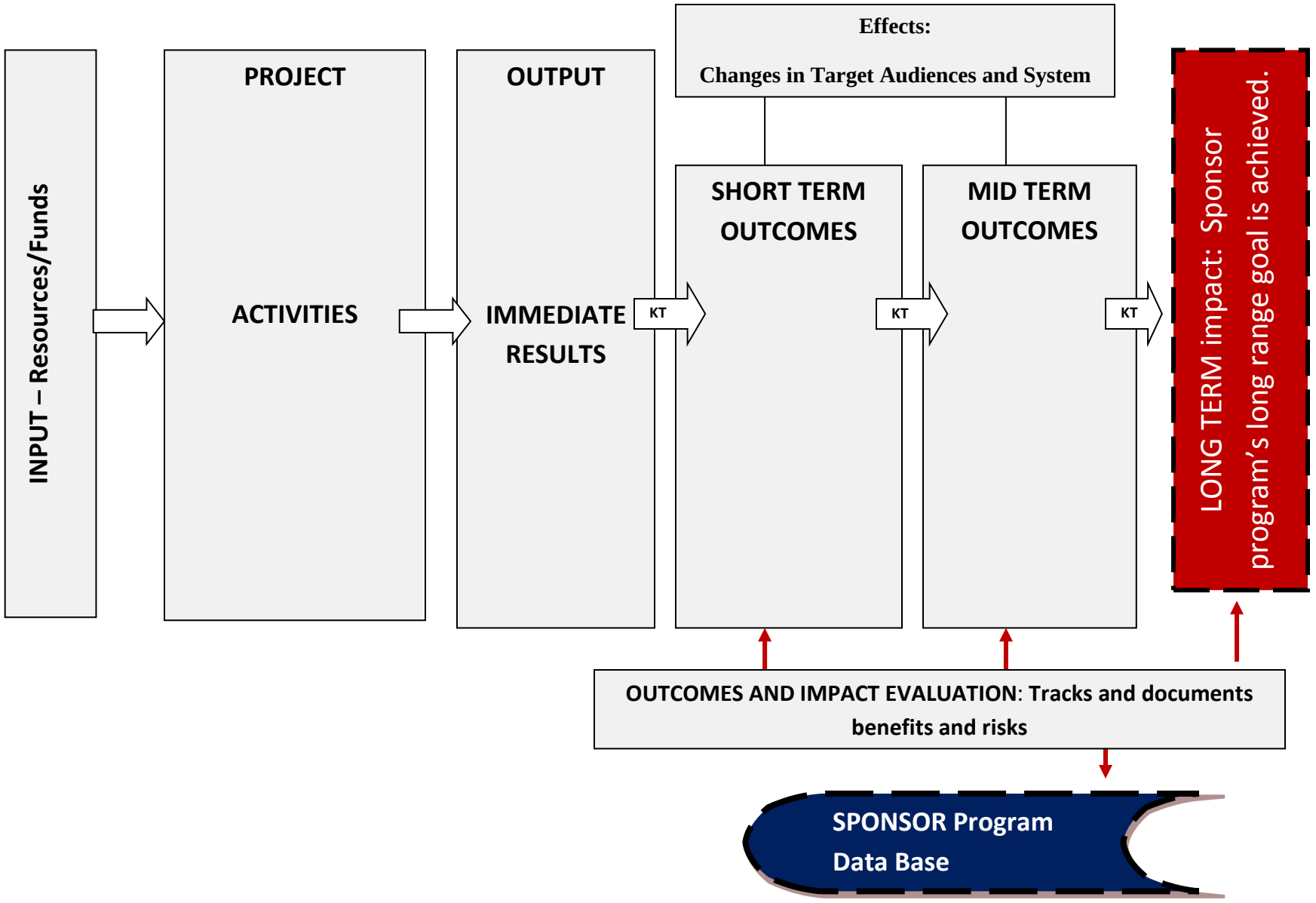

Figure 4. The bridging role of KT in the R-D-P Logic Model

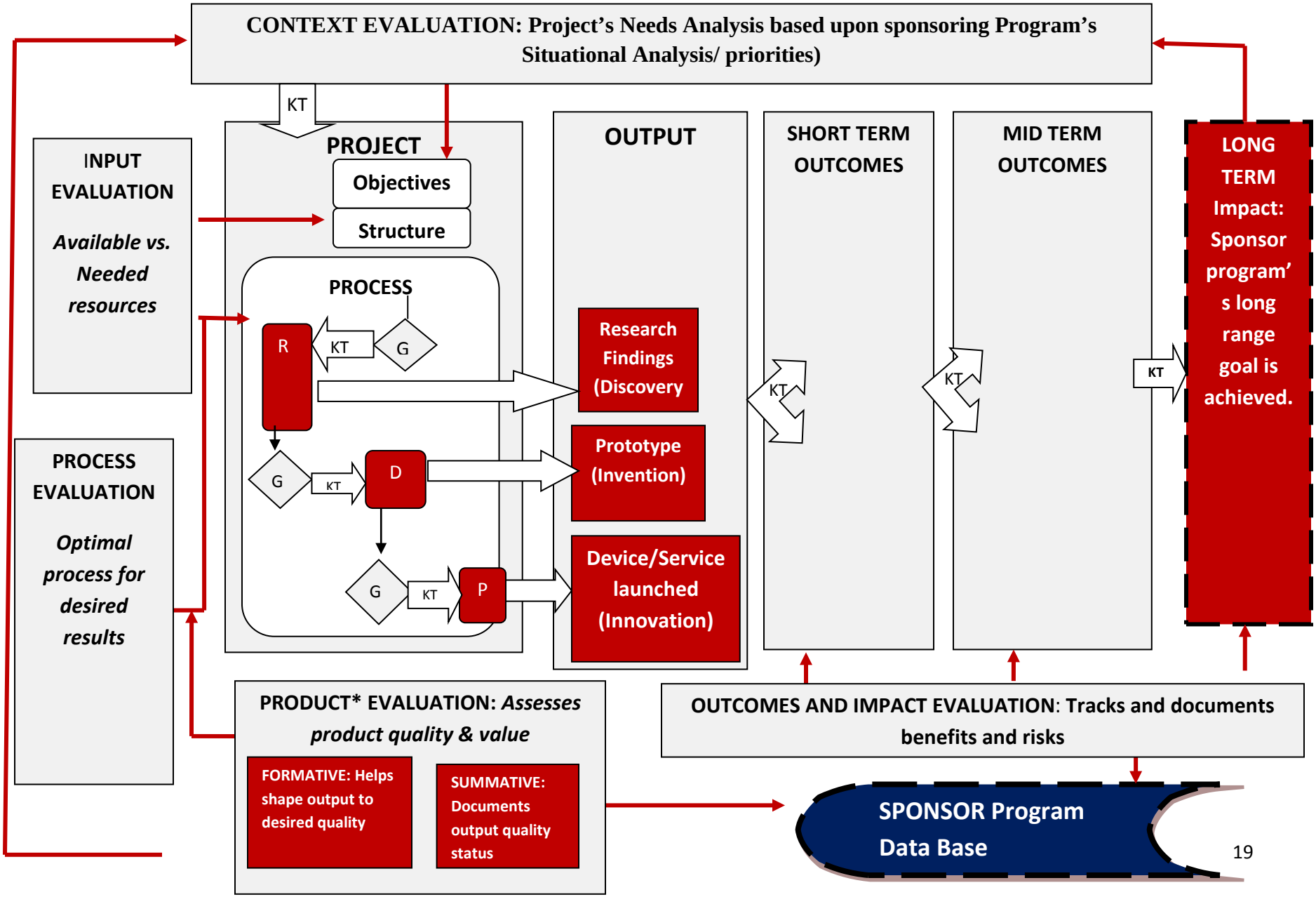

Figure 5.Progression of R-D-P Outputs through Outcomes to Impact

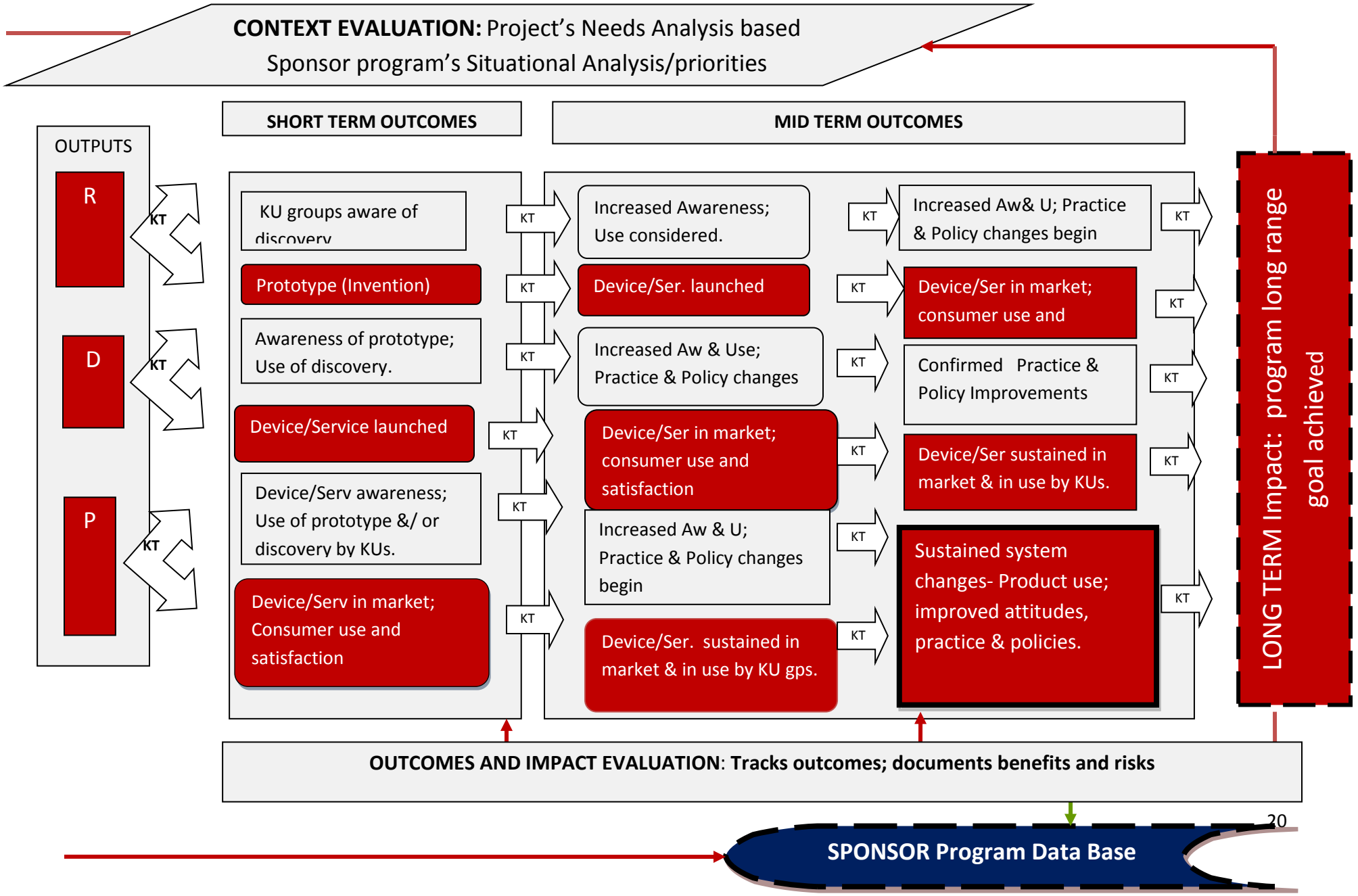

Figure 6. A Framework to Evaluate KT4TT: Begin right and Build relevance