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Constraint Classification for Projects
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This presentation discusses the findings of recent research that explores extending the application of TOC to the broader realm of project management. The existing TOC application to project management, critical chain project management (CCPM), has been a controversial topic.

On the one hand, CCPM has been praised as being the direction for 21st century project management and on the other hand it has been criticised for its lack of applicability to all projects.Neither side of this debate has made an attempt to define a clear boundary for CCPM applicability.

As a result, major improvements achieved through CCPM application have been underappreciated, due to not being generalizable, by the broader project management community. This research set out to explore and articulate the boundaries of CCPM's applicability. According to Goldratt (2009, p. 336) *"Application makes assumptions (sometimes hidden assumptions) about the environment. We should not expect an application to work in environments for which its assumptions are not valid."*

Exploring why and how an application works in a given context, requires in-depth analysis of both the application and the context. Therefore, a comprehensive theoretical analysis of over 600 published papers in CCPM was used to extract CCPM assumptions. In addition, a research study based on 10 cases provided insights into a diverse world of project management contexts, from industries such as construction, software, service, policy making, and filmmaking.

TOC suggests focusing on the core constraint as the leverage point in any system. The core constraint is what prevents the system from **achieving more** of its **goal**. CCPM specifically suggests that the core constraint in every single project is the longest chain of activities. How did CCPM arrive at this very specific definition of the constraint? What assumptions were made about the goal of a project and how it is achieved? The CCPM literature implies that a project's goal has a predefined and fixed value which is set at the beginning of the project. This definition assumes that the throughput rate in the project can only increase if the duration of the project is reduced. While several projects in the case study research did exhibit this characteristic, there were also projects in which achieving more of the goal within the same project was possible. For this latter group, the value of the goal was variable and thereby the rate of throughput was not merely a derivative of duration.

In addition to looking at what the goal is, we also investigated what accelerates or decelerates achievement of the goal. In production, the bottleneck determines the rate of throughput. VATI analysis suggests locating the bottleneck based on workflow. Given the fact that projects are more diverse than plant types in production, it seems that the diversity of workflow in projects has been overlooked by CCPM. In particular, the driving force for achieving the goal is human resources. While machines and their locations define the workflow in a manufacturing plant, project workflow is defined by the availability or arrangement of human resources and how they interact. CCPM literature highly emphasises the relayrace concept. This metaphor depicts a sequenceof passing a baton. In some of our case projects the baton (the project) was sequentially passed between different trades or different people with specific skills. However, there were also projects executed by dedicated cross-functional teams for which the relay race seems to be irrelevant.

Therefore, we conclude that projects can be classified based on the above characteristics into two dimensions. One dimension divides projects according to the value of their goal: namely into variable and fixed goals. Another dimension splits projects according to the arrangement of human resources: ie into dedicated versus non-dedicated teams. This model is demonstrated in this presentation.

In order to exhibit how the constraint can change in each quadrant of the above model, one CCPM case along with four other cases were explored in further detail. Examples will be presented using two TOC thinking processes: goal tree and current reality tree. Example cases are as follows:

Case 1: A software development project with a **fixed value** for its goal that was executed bya **non-dedicated team**. The project was internal, and the goal could have had variable value. However, chunking and iteration enabled defining a measurable and precise goal with the fixed value at the beginning of each sub-project. This process facilitated effective application of CCPM.

Case 2: Another software development project used the Waterfall method and then shifted to using Scrum. The project was bound by a contractual agreement and thereby had a **fixed value** for its goal. However,unlike the CCPM case, it was executed by a **dedicated team**. The structure of the team in this project differed from the structure of the CCPM project. An interesting finding of this case was that a dedicated team with cross-functional team members can manage variability without a time buffer. Daily stand ups played the role of both drum and rope; it provided a daily adjustment thatallowed the team to move forward at the same pace. Cross-functional team members can offer each other help and thereby reduce variability in the project. The project team on a daily basis discussed the status of their work and every negative variability was absorbed by a positive variability. The case clearly shows that dedicated cross-functional team members do not pass the baton; rather they carry it together to the end. The rate of throughput is defined by the capacity of the entire team.

Case 3: this was a web development/service project. The project was an internal project with no contractual agreement. The project team aimed at getting the best possible output in terms of quality, content, usability and usefulness with resources that they had. As such the project had a **variable goal** that could increase or decrease within the same project. The project was executed by a **non-dedicated team,** each member of which had a specific role and was responsible only for specific types of

tasks. Therefore, this project was similar in terms of its team structure to the CCPM case. However, not in terms of its goal. One observation in this case was that since the team was not dedicated to the project, buffer management was required to manage the sequential process and avoid waiting times. However, since the goal was variable, the throughput of the system was not driven by duration. Constraint analysis using a goal tree and current reality tree indicated the core constraint in this project was, in fact, a chain of interpretation and communication. This chain of interpretation increased the gap between the ideal outcome and the actual outcome.

Case 4: this case was a policy advisory project in a government department. The case contravened CCPM characteristics both in terms of its team structure and its goal. The project had a cross-functional **dedicated team** and a **variable goal**. The project involved a research component. The case is an example of a fairly recent phenomenon: project management today is applied to many undertakings that were not considered as projects in the past. Uncovering the goal was perhaps the biggest challenge of this project. This case is similar to Case 3 in terms of its goal: both cases exhibit a variable goal. The core constraint for both cases was found to be beyond the logistics of the execution process. Improving a process that expected to deliver an unknown output requires a different perspective altogether. Such projects need exploration strategies instead of exploitation techniques.

The above four cases suggest that different constraints apply for each of the four quadrants of the classification model developed in this research. The constraints are summarised as follows:

	Non-dedicated team	**Dedicated team**
Goal with fixed value	Case 1: longest chain of activities	Case 2: capacity of the team
Goal unit variable value	Case 3: longest chain of interpretation and communication	Case 4: uncovering unknown scope

Table 1. Two by two classification of project constraints

A further case example, from the construction industry, had a **non-dedicated team** and a **fixed goal**,which indicates that CCPM should apply. They did not use CCPM however. The analysis of the case indicated that the core constraint was the longest chain of activities. This analysis was only focused on the project goal. It is worth noting that single projects are only a subset of the larger system. CCPM multi-project application attempts to prevent falling into the trap of sacrificing the global optimum (the overall organisation) for the sake of local optima (for each single project). However, in this project the attempt to identify this larger system and its owner only led us to discover that various contractors operated as independent systems with no unified goal. A key finding of this case is that unity of purpose is a prerequisite to application of CCPM. It is possible to facilitate unity of purpose using contractual agreements such as alliance contracting. Nevertheless, without unity of purpose, it is not possible to determine what the actual constraint is.

The latter case triggered further research. We conducted further theoretical analysis to uncover other prerequisites to the applicability of CCPM. Numerous assumptions would have been made when proposing CCPM. In order to manage such a broad topic, we used basic categories of concepts previously used in project management: time, scope, human resources, planning, execution, and closing. Text analysis and content analysis were used and will be presented briefly for each concept area. Disscusion leads to an understanding of multiple theories in project management and broader management that contributed to CCPM assumptions. In particular, these theories define the project-related concepts to which TOC is applied. Some of these theories have contextual implications while others may have a broader range of applicability. The presentation concludes by suggesting five prerequisites to applicability of CCPM: urgency, logicality, nature of the workflow, arrangement of human resources, and unity of purpose.

Refrence: Goldratt, E. M. (2009). Standing on the shoulders of giants: production concepts versus production applications. The Hitachi Tool Engineering example. *Gestão & Produção, 16*(3), 333-343. doi: 10.1590/s0104-530x2009000300002

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In 2012, she embarked on a PhD at Victoria Business School, Victoria University of Wellington, New Zealand. Her PhD thesis is titled 'Broadening the Application of Theory of Constraints to Project Management beyond Critical Chain Project Management'.

Maryam's PhD topic reflects her two major areas of research interest: TOC and project management. She is a current member of TOCICO and has been working on the TOC Academic Database project led by Prof. Vicky Mabin since 2013. She is also a member of PMI and Agile Alliance and has been an active researcher/practitioner of project management since 2002. In addition to her postgraduate research on project management, she worked for several years as project manager and Project Management Office (PMO) manager. She has worked on some of the largest construction projects in Sri Lanka including post-tsunami reconstruction projects.

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In 1987, Vicky spent several months in the USA, as a Visiting Research Fellow at George Washington University, visiting many companies in the early stages of using TOC (then OPT). She led the first application of OPT in NZ at Expozay International, and has used TOC in her research, consulting, teaching and administrative roles ever since, most recently as inaugural Associate Dean Teaching and Learning at Victoria Business School, developing Assurance of Learning processes and leading teaching and learning projects.

Vicky's publications include "*The World of the Theory of Constraints: A review of the international literature*" (2000), the lead chapter on the Thinking Processes in the "*Theory of Constraints Handbook*" (2010), and many journal articles on TOC, MCDA and related areas. She leads the project to establish a comprehensive database on academic TOC papers, and is editing the TOCICO White Paper Series. She has supervised several PhD projects on TOC. An academic Jonah, she has a PhD in Operational Research, University of Lancaster, UK, and a Postgraduate Certificate in Higher Education Learning and Teaching; is a Fellow of the Operational Research Society (UK), past president of the Operational Research Society of New Zealand, and past Chairperson of the Wellington Chapter of the NZPICS. She has served on the examinations board for TOCICO, and as an editor for the *Decision Sciences Journal of Innovative Education,* and *International Transactions in Operational Research.*

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