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İNŞAAT SEKTÖRÜNDE
PROJE DEĞİŞİKLİK YÖNETİMİ

YÜKSEK LİSANS TEZİ

Mimar Göktuğ Bilgin

Tezin Enstitüye Verildiği Tarih : 27 Ocak 1997

Tezin Savunulduğu Tarih : 4 Şubat 1997

Tez Danışmanı : Prof. Dr. Heyecan Giritli

Diğer Jüri Üyeleri : Prof. Dr. Zeynep Sözen

Prof. Dr. Yıldız Sey

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T.C. YÜKSEKÖĞRETİM KURULU
DOKÜMANİSYON MERKEZİ

PROJECT CHANGE MANAGEMENT
IN CONSTRUCTION INDUSTRY

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ABSTRACT

Owners, designers and construction contractors are all aware that introduction of changes into a project can lead to problems and hinder project success. Changes may interrupt the flow of work, create delays, cause schedules to slip and inflate costs, which in turn may generate claims even costly litigation.

As a consequence, this thesis is established to find solutions to, or, preferably, the means of avoiding such problems. An extensive literature review has guided this research which is now ready to present its findings to the industry.

This research focused on determining the nature and origin of problems related to changes. The elements of a project that are subject to change have been categorized. The relationship between the occurrence of changes throughout the life cycle and their impacts have been established. As a result of this research, three primary deliverables are provided to the industry: (1) a comprehensive view of changes, (2) a set of principles for effective management of change, (3) a prototype change management system.

This research provides these deliverables, beginning with a detailed descriptions of project changes, followed by a discussion on their causes, types and impacts. A description of a typical project life cycle and the dynamics of change management are then presented in Chapter 3 on the basis of each of the project phases. Next, the principles of effective change management are identified. Finally, a prototype change management system is included as Chapter 4.

Highlighting the principles of effective change management, they are: a balanced change culture, recognize change(when it occurs), evaluate change, implement change and continuously improve from lessons learned.

The research states that significant savings in total installed costs of construction projects are achievable by improving management of changes. Owners and contractors can profit from increased efficiency. Schedules can be made more reliable, and end-user satisfaction can be enhanced. The industry can immediately benefit.

ÖZET

İNŞAAT SEKTÖRÜNDE PROJE DEĞİŞİKLİK YÖNETİMİ

İnşaat sektörünü incelediğimizde, proje kapsamlarının ve buna bağlı olarak süreçlerinin karmaşık bir yapıya büründüğü sonucuna varmak hiçde zor değildir. Sektördeki rekabetin ve anlaşmazlıkların artmasının temel nedeninin bu olduğuda açıkça belirlenmiştir. Bütün bu etkenler göz önüne alındığında, anlaşmazlıkların çözüme ulaştırılabilmesi için hukuki davaların çoğalması kaçınılmaz olmaktadır. Ortaya çıkan bütün bu olumsuzluklara rağmen, projelerin elde edilebilecek en yüksek kalite ve uygun maliyetlerle gerçekleştirilmesi bütün proje gruplarının temel hedefidir. Bu sebepten dolayı, inşaat projelerinde istenilen performans ve beraberinde getireceği ticari hedeflere ulaşabilmek için birçok değişiklikler yapılmaktadır.

Projelerde gerçekleşen bu değişiklikler, projelerin inşaa evrelerinde proje gruplarının karşılaştığı en büyük problemlerdir. Bu nedenle çoğu iş veren, mimar veya mühendis, yükleniciler ve bütün taşeronlar değişiklikleri birer büyük engel olarak kabul etmekte ve değişikliklerden çoğu zaman kaçınmaya çalışırlar. Projede meydana gelen değişiklikleri bir sistem yardımı ile etkin bir şekilde yönetmeyi konu alan bu çalışmada ise, projede gerçekleşen değişikliklerin birer engel değil, proje performansını arttırıcı birer etken olarak kullanılabileceğini benimsetmek hedeflenmiştir. Ancak bu hedefe ulaşabilmek için, değişikliklerin bir sisteme oturtularak etkin bir şekilde yönetilmesi gerekmektedir. Çalışmanın amacında bu sistemi oluştururken, sisteme yarar sağlaması açısından; değişikliklerin nasıl tanımlanması gerektiği, değişikliklere neden olan etkenler, çeşitleri ve değişikliklerin getirisi olarak ortaya çıkacak etkilerin, proje ekipleri tarafından tam olarak kavranmasını sağlamaktır.

Bu sistemi oluřturmadaki ama, deęiřikliklerin etkilerini kontrol ederek, asgariye indirebilmektir. Bařka bir deyiřle, taraflardan herhangi birinin meydana gelen bu deęiřikliklerin sonularından zarar grmemesini saęlamaktır.

ncelikle projedeki deęiřikliklerin karmařık yapısını zezebilmek iin alıřmaya deęiřiklięin tanımı yapılarak bařlanmıřtır. Buna gre, deęiřikliklerin szleřmelerin esaslarına gre tanımlanmaları gereęine varılmıřtır nk oyunun kurallarını szleřmeler belirler.

Projedeki deęiřiklikleri tanımlamak sistemi oluřturmak iin yeterli olmayacaktır. Hatırlanılması gereken projeler tamalanana kadar proje srecinde eřitli nedenlerden tr birok deęiřiklik meydana gelecektir. alıřmanın esası; sistemi oluřtururken deęiřikliklerin nedenlerine sebebiyet verebilecek durumlara engel olabilmek iin, deęiřikliklerin nedenlerine ařına olunması temeline dayanır. nk bir sorunu zmleyi bilmek iin nedenlerini ve niinlerini bilmeden iyi bir zme varmak tahmin edebileceęiniz zere olduka zor olacaktır.

Bugne kadar yapılan birok arařtırmada projelerde meydana gelen deęiřikliklerin nedenleri incelenmiřtir. Bu alıřmada ise genel deęiřiklik sebeblerinin dıřında deęiřikliklere neden olabilecek ve daha nce zerinde nemle durulmamıř farklı nedenlere deęinilmiřtir. Bunun nedeni ise, deęiřikliklerin sebep-sonu iliřkilerinin birbiriyle doęru orantılı geliřmesidir

Daha sonra nceden yapılmıř alıřmalar ve arařtırmalar doęrultusunda inřaat sektrnde karřılařılan deęiřiklik eřitlerinden bahsedilmiřtir. eřitlerin belirlenmesi, nasıl meydana geldikleri ve sonularında neler doęurabileceęini tahmin edebilmek aısından olduka nemlidir. nk deęiřiklięin eřitlerine gre oluřturulacak sistem ve deęiřikliklere uygulanacak ynetim řekli farklı olmalıdır.

Aslında sektr bazında genel anlamda deęiřiklikler konusunda yanlıř bir uygulama yapılmaktadır. Projeye yapılan btn ilaveler, eksiltmeler veya tashihleri, deęiřiklik kavramı altına almıřlardır. Bu alıřmanın dięer bir amacı bu genellemeye bir sınırlama getirerek, projeye yapılan herhangi bir deęiřiklięin bir sistem ierisinde ynetilebilmesi iin bu deęiřikliklerin projedeki tm gruplar tarafından yazılı olarak

talep edilmesi gerekliliğini vurgulamaktır. Bu sayede bir anlaşmazlık durumunda, taraflardan herhangi biri bu değişiklik taleplerini yasal olarak başlatabilir.

Burada bir proje yöneticisi açısından önemli olan, değişiklik emirlerinin sözleşme dökümanlarının bazı şartlarını ve belli terimlerini değiştirmeye yarayan resmi bir kayıt olduğunu, herhangi bir hukuki davada taraflar için yarar sağlayacak ve tartışmanın çözümlenmesinde delil olarak değerlendirilebilen resmi bir belge olduğunu unutmamaktır.

Projelerde değişikliklerin etkin bir şekilde yönetilmesi için oluşturulması hedeflenen sistemin başarılı sayılabilmesi, taraflarca onaylanan bu değişikliklerin proje üzerindeki etkilerinin son derece dikkatli bir şekilde teşhis edilmesiyle sağlanabilir. Genelde proje grupları özellikle süreç ve maliyet açısından bu etkileri inceler. Ancak maliyetler ve süreçler üzerindeki bu negatif etkinin insan ilişkilerini ne derece zayıflattığını da göz ardı etmemek gerekir. Süreçler ve maliyetler kontrol edebilen ve boyutları ölçülebilen etkilerdir, fakat eylemin gerçekleşmesinde mesai harcayan ekipler işlerinin durdurulduğunu, iyi veya kötü herhangi bir şekilde değiştirilmesi gerektiğini ve bunun için fazladan mesai harcamaları gerçeğiyle yüzleştiklerinde, moral ve verimlilik üzerinde negatif etkiler oluşmaktadır. Bu gibi etkilerin proje grupları tarafından ne kontrol edilmesi ne de herhangi bir boyutunun ölçülebilmesi mümkündür. Bu etkilerinde uzun dönemde ikili ilişkilerde sorun yaratabileceğini hatırlatmada fayda vardır.

Bütün bu tartışmaların dayandığı ortak nokta, değişikliklerin; inşaat projelerinde yer alan taraflara yönelik bir dizi sorunun başlıca kaynağı olduğudur. Aslında proje sırasında yaşanan birçok sorun, değişikliklerin nedenleri ve etkileri konusunda meydana gelen fikir ayrılıklarından doğmaktadır. Amaç, öngörülen değişikliklerin hangi tarafın sorumluluğu olduğunu belirleyebilmektir. Bunun için inşaat sektöründe birtakım terimler belirlenmiştir, ancak bu terimlerin kesin olarak tanımlanamaması ve bunların sözleşme şartlarına uyarlanamaması, taraflar arasında hukuksal bir anlaşmazlığa da yol açabilir.

Bütün bu karmaşık yapının etkili ve çabuk bir şekilde çözümlenebilmesi proje yönetim gruplarının nitelikleriyle doğru orantılıdır. Ancak günümüzün karmaşık proje organizasyonları, çelişkili proje kontrol yöntemleri ve eksik proje yönetim sistemleri grupların bu önemli niteliklerini negatif yönde etkilemektedir.

Bu çalışmanın hedefi; projeler üzerinde negatif bir etki yaratan değişikliklerin, bir sisteme oturtularak etkin bir şekilde yönetilebilmesi ve bu sayede proje ekiplerinin değişikliklerden faydalanabilmesini sağlayabilmektir.

İnşaat sektörünü incelediğimizde çok sayıda değişiklik yönetim sistemlerine rastlanabilir. Bu sistemlerin çoğu değişiklikleri etkin bir şekilde yönetmek için yeterli bulunamamıştır. Bu çalışmada ise sektörde var olan diğer yönetim sistemlerinin eksikliklerini belirleyerek elde edilen temel prensipler üzerine kurulabilecek bir örnek sistem oluşturmak amaçlanmıştır. Oluşturulmak istenen bu sistemi kullanarak değişiklikleri yönetebilmek mümkün olabilir. Ancak çalışmanın hedefi etkin bir yönetim olduğu düşünülürse sistemi oluşturan prensiplerin en iyi şekilde kavraması gerekliliği ortaya çıkmaktadır.

Sistemi oluşturan bu *beş temel prensibi* kısaca tanımlarsak:-

1. Projede değişiklik yapılabilmesi için uygun ortam yaratmak;
2. Meydana gelebilecek değişikliklerin farkedilebilmesi;
3. Değişikliklerin değerlendirilmesi;
4. Değerlendirme sonucuna göre uygulanması;
5. Yapılan uygulamalar sonucunda edinilen derslerin ileri projelerin geliştirilebilmesi için kullanması.

Ancak sistemi oluşturan bu prensiplerin uygulanabilmesi için, projede yer alan taraflar bazı ön şartları yerine getirmelidirler. Bu şartlar taraflarca ortak bir karara bağlandığı takdirde, değişikliğin yapılabileceği uygun ortamdan bahsedilebilir. Önce projeye dahil olan tüm tarafların değişiklikleri fark etmesi ve onlara karşı hassasiyetlerini arttırmak konusunda ortak bir anlaşmaya varmaları gerekmektedir. İkinci şart, potansiyel değişikliklerin planlanmasının projede mümkün olduğunca

erken yapılmasıdır. Üçüncü ve son ön şart ise projedeki tüm tarafların değişikliklerin değerlendirilmesini ve en kısa zamanda üzerlerinde karara varılmasını kabul etmiş olmasıdır. Bu şartlar sağlandıktan sonra sistem etkin bir şekilde uygulanabilir.

Sonuç olarak bu çalışmanın sektöre sunmayı hedeflediği değişikliklere ilişkin yönetim sisteminin bir örnek olduğu unutulmamalıdır.. Bu sistem ve prensiplerinden yola çıkılarak, proje yöneticileri kendi değişiklik yönetimi sistemlerini oluşturmalarıdır. Proje yöneticilerinin unutmaması gereken en önemli konu, inşaat aşamasında projede yapılan değişikliklerin belirli bir sistem doğrultusunda etkin bir şekilde yönetmesi gerçeğidir. Çünkü bu evrelerde projelerde yapılacak değişikliklerin doğuracağı problemler, projelerinin başarısını doğrudan etkileyecektir.



CHAPTER ONE:

INTRODUCTION

Generally, when a project is in trouble, the problems stem from changes that have occurred. In order to minimize and control changes, project teams must thoroughly understand what they are, why they occur and how they should be resolved.

This research will address changes from several perspectives in order to prevent changes from becoming a project albatross for construction industry.

1.1 PROBLEM IDENTIFICATION

This thesis focuses on the term; “change”; which owners, designers, and construction contractors (stakeholders), are all keenly aware of during the life cycle of any project.

As project management is a relatively young profession and while there is commonality around about what is done, there may be little confusion in the terms used. The potential dispute is that of a business, not personal and the participants of projects wish to be successful and to make profit. Hence, the aim of taking the risk of a project is achieving success, it is vital to understand how success is perceived. The success of the project is measured via the achievement of project goals with respect to needs, time and cost. (see Figure 1.1)

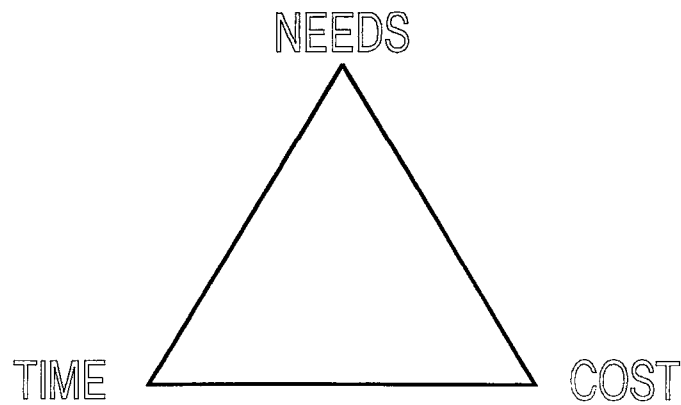


Figure 1.1 Goals Triangle

The overall key to a successful project is through precise managing. Project is -a *unique undertaking for essentially a single purpose which is defined by scope, quality, time, and cost objectives*- but on the contrary project management is not a “unique process”, it interacts with various project areas. Figure 1.2 portrays the major areas of actual project that directly correlate with risk and success- the contract, the schedule, and the administration of changes.

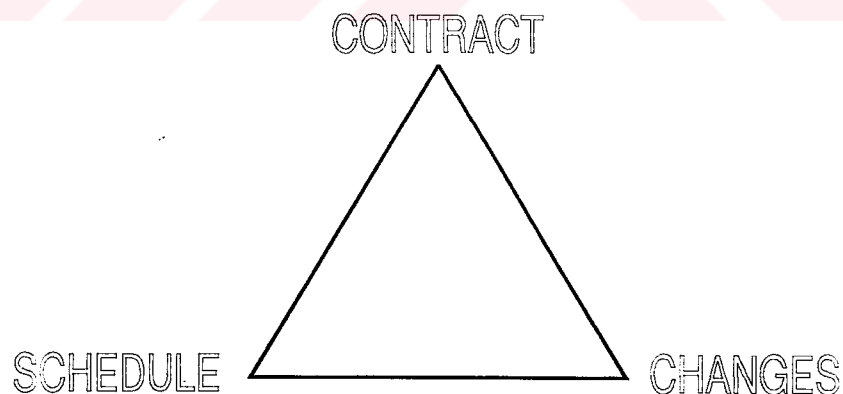


Figure 1.2 Project Areas Triangle

One of the most challenging areas of management on construction projects are those of changes. Changes may interrupt the flow of work, create delays, cause schedules to slip and inflate costs, which in turn may generate claims and even

costly litigation. If you want to resolve them, with minimum impact on project performance before the attorneys get involved, then your vehicle would be a change order. At the present, litigation in construction contracting is more prevalent than ever before so it should be better to step back the fray and use a neutral language to avoid igniting conflagration.

The dispute emerges from the planning of the business, because no project will ever be designed, planned or executed so perfect that changes are *inevitable*. As a result of this fact, the change order process becomes more important. So it is not enough to argue changes. They have to be particularly considered. It is better to keep in mind that changes are unavoidable so project teams should try to *manage changes instead of omitting them*. Changes arise for a variety of reasons during the development and execution of a project. In order to effectively manage changes a project manager must be familiar with the causes and plan to avoid situations which give rise to them.

The problem occurs in the absence of common terms and specific contract conditions which can directly lead to dissatisfaction and litigation. For example, some changes are necessary and beneficial while others may be discretionary and detrimental. On the other hand, changes may be required to correct errors or omissions. Besides changes in scope may also be demanded for either economic or functional reasons. The list goes on. The common term of each example is of course, *change* but still there are various opinions of what is a change to a project or/and of what are the causes and impacts of it.

1-2 SCOPE AND OBJECTIVES OF THE RESEARCH

The construction industry is increasingly competitive and litigious, project schedules and financial problems are aggressive and project scope is complex. Today's fast-faced highly competitive construction environment often forces owners, designers and contractors to make a variety of agreements on any project, with corresponding variety of "changes". Thus, changes can never be eliminated as they are the inheritors of causes and effect of "success" or "failure". If change is managed

effectively, “success” results, which means owners and contractors can profit, schedules are reliable, and end-user satisfaction can be enhanced.

The success of the project is measured in the achievement of project goals with respect to- needs, time and cost. Virtually every construction project has three participants- owner, designer and contractor- who must work together toward a common goal of getting the project built on time and within the budget. Simultaneously another important goal is to avoid ending up in court. The specific areas that have been addressed above are all related to the concept of “Project Management”.

Project Management is - “the art and science of directing human and material resources to achieve stated objectives within the constraints of time, budget and quality, and to the satisfaction of everyone involved”. Simply, it is the process applying management techniques and systems to direct and control suitable resources in order to successfully deliver the intended scope of any project. Figure 1.3 illustrates the project management model as a three-dimensional matrix.

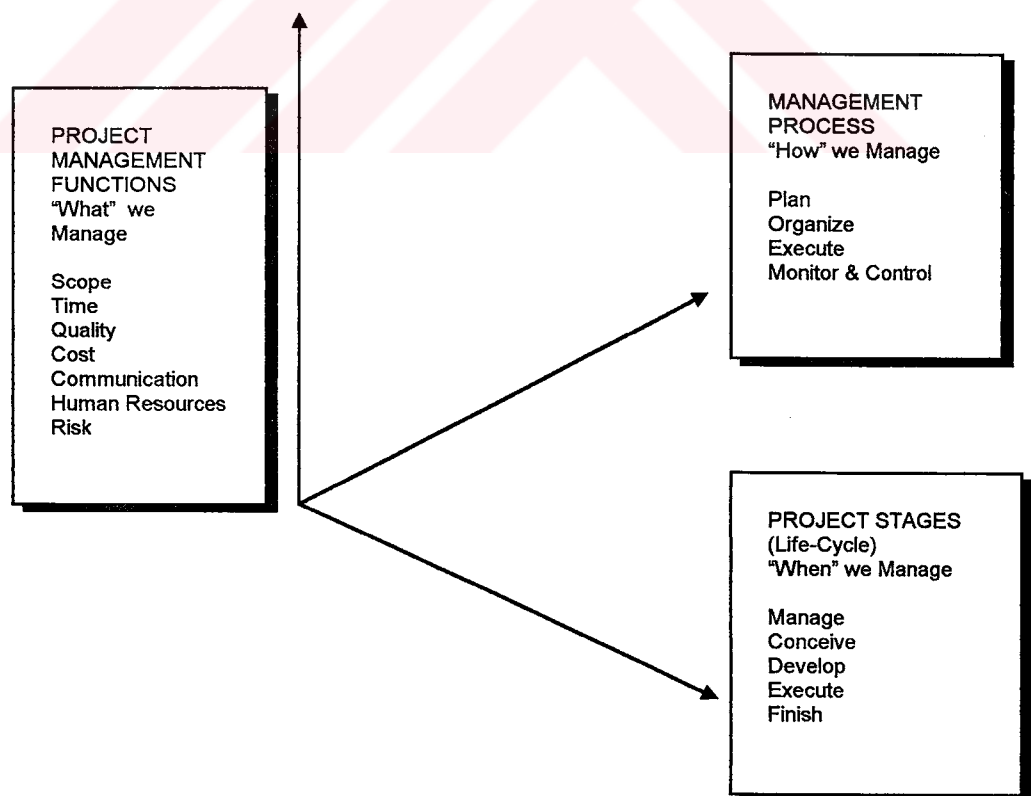


Figure 1.3 Project Management Model

The traditional approach to project management is its single-minded focus on a fixed set of tools for dealing with *constraints of time, budget, and quality*. These tools are well-known so project management must explore the use of new management tools. Project Management is obviously not a unique process, it integrates with the specific project management functions. Traditionally, these functions have been specified as- Project Scope Management, Project Time Management, Project Quality Management, Project Cost Management, Project Communication Management, Project Human Resources Management, Project Procurement Management and Project Integrated Management. Changes - addition, deletion, or other revision within the general scope of a contract that cause an adjustment to the Contract Time and Contract Price- present a variety of challenges for every party to any construction project. "Change" is always argued as a subset of scope, time, quality, cost, and risk but it should be right to consider as a specific functions. So the boundaries of the application of project management should be expanded into a new area, particularly the "management of change". "*Project Management will essentially be the management of change*", is then the subject of the research.

Thus means that constructions projects are likely to require changes in order to meet business needs and objectives. As a result of this fact, project management team must have the ability to respond to any change expeditiously and effectively. This ability to respond, however, is complicated by a variety of project organizations, project control system and work execution system. In spite of this complexity, in order to accomplish the project management team as a whole deals with changes, if and when they occur. So the big question is: "*Is the system prepared to deal with it?*"

The scope and objectives of the research directly relate to the answer of this question because most parties involved in projects imply certain change management procedures which mostly deal with *what to do after the need for a change occurs instead of how to manage it and its impacts*.

To ensure that the intended project outcomes are achieved, it is necessary to point out that project execution includes a change management process that will deal with these complexities and minimize interference and disruption to the project execution plan. And the management process utilized should be appropriate for the project

phases, the degree and definition that exists, and the type of the agreement and risk allocation in place. Because *change can best be understood in the context of agreements*. By having a *change management system in place*, a project manager will be able to better understand the complexity of the project and to better communicate with all project participants.

Changes on project stem from a broad array of sources, which means that “Change Management” should vary with the complexity created by change as the project moves through the different project phases; such as, the type of project, project agreements and contracts, and project schedule.

Consequently, an effective change management system should allow for the complex dynamics- regardless of the type and magnitude of a change- that are likely to develop, and should provide a disciplined approach for recognizing, evaluating, and implementing changes in a balanced culture.

1-3 THESIS LAYOUT

This research begins with a detailed identification of why changes are an inevitable problem for construction projects, followed by a statement of what is the scope and are the objectives of the research.

The research continues with general definitions of project changes. Then basing on an extensive literature review, causes and types of changes are mentioned. The change order process and their impacts are also included.

The research proceeds to a description of a typical project life cycle, followed by a discussion of the dynamics of change management. Next, the principles of effective change management are presented, followed by a conclusion of the importance of change management.

Finally, the prototype change management system is established with which changes to a project can be easily dealt.

CHAPTER 2:

PROJECT CHANGES

One of the great frustrations project teams face, while working on their projects, is changes. In order to effectively manage changes, the project teams must thoroughly understand what project changes are, why they occur and how they should be implemented.

Basing on a great literature review, this chapter first addresses what project change really means. Second it addresses the causes of changes. Next it states the types of changes which seem to be common on today's projects. The discussion then moves to the impacts of changes which will be useful for a superior knowledge about changes.

2.1 GENERAL DEFINITIONS

"It's an architect's inevitable appendage and a contractor's unenviable burden. Changes are like water weed in a lake. They show a little bit on the top but they grow thickly beneath the surface. The Captain can steer the boat down the middle or he may even find it necessary to have a short excursion through the weeds, but if there is too much passage through the weed beds then the whole boat is slowed down, and eventually there may be a nasty snarl-up." [1]

The portrait expressed above illustrates how players of a project view any change in a project. When a project is in trouble, the problems generally stem from changes that have occurred. As a consequence, the understanding of changes is important in order to effectively manage them. Project management teams are commonly

able to identify why changes occur during the project life cycle, what the impacts of changes are or how project changes can be controlled and minimized, etc., but they can not determine a precise definition for the term- *change*. The primary goal of this thesis is to define change in a common lexicon in order to stop or prevent confusion and also set up a baseline for effectively managing project changes- relying upon the fact that it is impossible to clarify the problem before getting *what it really means*.

Since the noun, change is defined as:- *any variation or alternation in form, state, quality or essence* [2]- it does not seem to be as complex as it is defined during the phases of project life cycle. Simply, a change is any work required for a contractor or subcontractors that was not specified in the original contract documents.[3] In other words, the contractor is being required to perform something different from what it was agreed to be done. In a case of mutual agreement, this expression satisfies the situation, but today's complex construction contracts need a more formal definition to avoid disputes or arbitration/litigation. Therefore, a great literature review has been done to provide a common wording of *change*.

The primary purpose of this research is to state a formal definition that will clarify the confusion and help the players to understand what project changes really mean- that is, the understanding of project changes is vital to achieve the objective of the thesis. As portrayed in Figure 1.2 the contract and the administration of changes directly correlate to the success of the business; so the term, change:- *additions, deletions or other revisions within the general scope of a contract that cause an adjustment to the contract price and contract time* [4]- must be defined in terms of any standard contract document, hence *the contract spells out the rules of the game*.

2.2 CAUSES OF CHANGES

Changes arise for many reasons during all phase of any project life cycle. The main objective of this thesis is to set up a *prototype change management system*, basing which on the *principles of effective change management*. As a consequence in order to effectively manage changes, the project team must be familiar with the *causes of changes* and plan to refrain from situations which give rise to change. So

this section will address the causes of changes in order to avoid them during the conceptual and development stages (pre-construction).

Various studies examined the reasons why changes occur on a project. The factors that affect the occurrence of changes are commonly expressed as- defective specifications, building type, differing site conditions, owner/user type, project team organization, miscommunication and the list goes on. These known causes of changes will not be rehashed in this research. This section will focus on four different causes that have not been given enough importance previously.

The occurrence of changes starts with the planning of any project. It should be stated that *planning of the project* has not been discussed although it is the primary reason why changes occur on any project. Mostly, projects are best planned after a participant has had major problems on a preceding project because of changes. Therefore, planning must be well done up to reduce the risk of change during actual execution. However, planning must be comprehensive and foresighted. For instance, traditional *design-then build approach* results in less number of changes than a fast-track approach. Obviously using a fast-track approach will result in a particular set of risks. Since, a project's overall design is not complete when construction begins, there has been no opportunity to review and coordinate drawings. As a consequence, there is normally a higher incidence of changes on such a project.[3, p.19-20]

The most important causes of changes that occur include *errors and omissions*. Errors and omissions are inevitable and it is why a contingency should be allowed on each project. But the incidence of errors and omissions can be reduced by *design and constructability review*.

Design Review- one cause of change is the presence of errors and omissions in the plans and specifications. It must be recognized that no set of plans and specifications will be perfect, but they should be as error-free as possible. A consideration in this area is to have an outside or independent design review performed before the plans and specifications are issued for bid. This can even be an ongoing process while the design is progressing as opposed to a review when the design is complete. The review should note any ambiguities or conflicts detected. It is often *beneficial* that the reviewing firm looks at the documents as a contractor would, when bidding

and constructing the project. An outside design review probably will not detect errors, but generally will pay for itself by uncovering a number of changes that can be resolved up front.[3, p.29]

Constructability Review- similar to a design review is a constructability review. Although this review of the project prior to bid insures that the project can be built, "what gets built is not what the contractor originally plans to build." [5] That may sound facetious, but there have been too many examples of construction projects that could have been constructed as designed.[3, p.29-30]

Another reason, which causes changes, can be addressed as a contract- which is a management tool- in which the rules for any project are embodied.[3, p 55-64] A contract is a set of promises for the breach of which the law gives a remedy or the performance of which the law gives in some way recognizes an duty.[6] In its simplest form, it is an agreement between parties. Generally, when you agree upon certain items in a contract, one party can not *unilaterally* change them. Interestingly, construction contracts do not follow the rule that makes them unique. The main reason that construction contracts are unique is the virtue of the "changes" clause that is virtually contained in all of them. The changes' clauses allow the owner to make changes within the scope of the contract. The purpose of this clause is to provide a mechanism to accommodate the changes to the work that inevitably occur on a job. Not only it is establishing a mechanism, but it is also defining how the contractor will be compensated for additional cost and schedule, and what steps are required by the contractor if he believes a change has occurred.

As a consequence, this unique feature of construction contracts must be well understood and recognized in order to refrain from changes and end dispute. For example, the cost of changes is really evident on a lump-sum contract, hence, the contractor will submit a claim for change. Besides in cost-reimbursable contract, changes may be readily accepted because of the nature of the contract itself.[7, p.252-255]

In the pre-construction phase, another vital reason, why changes occur, can be stated as- *the method used in managing the project*. Project can be managed by traditional approach/management by designer or by general contractors, or by a

construction manager/project manager or even by the owner himself. Vitally any individual or party, who is going to manage the project, must be well versed in contracts, the meaning and administration of changes, advanced schedule techniques and proper methods of integration management because these major areas of project directly correlate with *success* and *risk*.

As a conclusion, to effectively manage change, the project team must be familiar to changes and must avoid problems that give rise to them, and if any change occurs, should try to implement it with minimum impact.

2.3 TYPES OF CHANGES

Unilateral Changes (sometimes referred as “directed changes”):- an authorization in the original contract documents that gives the right to direct the contractor to proceed with a change prior to an agreement on price and time actions. This authority is often exercised when the owner is dissatisfied with the contractor’s proposed price changes. Therefore, to avoid delays caused by price negotiations, the owner can force the contractor to proceed with the change before any negotiation. Although all changes require the contractor to pursue prompt payment, the unilateral change order requires special attention for the contractor to receive payment during the progress and upon completion of the change. The very minimum collected must be an amount that the other party considers to be appropriate. The balance to which the contractor is entitled must be negotiated, subject to the arbitration or litigation provisions of the contract.[8, p.67]

Stipulated Price Changes:- a fixed price change that is determined in the original contract documents. Normally, such a change occurs as a written amendment to the original contract documents. This amendment is based on information provided to the owner by the contractor, which sets forth additions to or subtractions from the original contract sum and alternations to the completion time. The amendment normally provides that all change orders must be signed by persons having the authority to amend the original contract. The determination of such persons and obtainment of written notification of this authorization from the owner should be done

immediately after the contract is accepted. Most certainly this should be done before any field work commences.[8, p.66]

Unit Price Changes:- changes authorized by the owner based on unit prices provided by the contractor in his bid. These changes are then incorporated into the contract documents by the owner. Unless how these unit prices are determined by the contractor, one can not predict and plan for various conditions that can impact the performance of any change. Still, these unit prices do not make provisions for special tools or equipment that might be necessary. Unit price requests often appear on projects that have been altered to “fast-track”. Fast-track is a type of performance specifications by which bids are requested and contracts are signed before all engineering and design work have been completed. These projects require an immeasurable amount of bookkeeping and negotiating. Because the architect or engineer is *winging it*, they are not really sure what they are doing. There is no schedule stability, and the design stability is also unsecured.[8, p.68]

Constructive Changes:- it is an informal act authorizing or directing a modification to the contract caused by the owner or architect/engineer through an act or a failure to act.[3-9] In contrast to the mutually recognized needs for a change, certain acts or failures to act by the owner, that are produced by the owner and that increase the contractor's cost and/or time of performance, may be considered as grounds for a change order. This is termed as a constructive change, however, it must be claimed in writing by the contractor as specified in the contract documents, otherwise the contractor may seem to be waiving his potential rights to collect.[9, p.470] In other words, constructive change is a common occurrence and a primary cause of disagreement between the owner and the contractor.[8, p.67-68]

As a consequence, constructive changes are the major causes of problems on any construction project. Managers who understand the concept will be able to assess whether it is a constructive change or not. While a veritable “laundry list” could be drawn up of the various forms of constructive changes, *examples’ help make the concept of the constructive change concrete*. [3, p.129-130]

A few common examples of constructive changes may be included as:

Defective Plans and Specifications:- the terms applied to a project correctly completed by a contractor from plans and specifications that he has altered to correct the defective portions of those plans and specifications. In other words, the equipment and work furnished does not conform the originals due to improvements and alternations made by the contractor. Under such a circumstance, all liability becomes that of the contractor's, even though his alternations were necessary to make the project a success.[8, p.69]

Higher Standard of Performance than Required:- only the minimum standard performance is required in accordance with the contract specifications. If an owner requires a contractor to perform above that, this may be a constructive order. For example; a contract specifies that an area must be backfilled with on-site material and compacted with three phases of a sheepfoot roller. The contractor backfills and compacts but the work is then not accepted because the soil does not pass a 90% modified Proctor test. This is an example of requiring a higher level of performance. To now require density to satisfy the modified Proctor test is a *change*. This type of constructive change is normally related to defective plans and specifications.[3, p130]

Engineering Errors and Omissions:- a term applied to a project incorrectly completed by a contractor from defective plans and specifications as the results of engineering errors and omissions. In other words, the completed project conforms to original plans, but the result is defective project due to the engineer/architect's defective plans. Under this circumstance, the engineer/architect is solely liable for his errors. The work must then be done over in accordance with new drawings at the engineer/architect's expense. Many times, however, the work is changed without new drawings. Such a circumstance is a disaster for the contractor, as there is no documentation of the changes, in which case the liability of the contractor increases.[8, p. 70]

Improper Rejection:- this type of constructive change is closely associated with the requirement of a higher standard of performance. It normally relates to the rejection of some performance criteria of the contract, which the contractor has complained of. For example; if the compaction noted in the example- requiring a higher standard of performance- is now rejected by the owner, it would be an improper rejection. Requiring the contractor to

compact to 90% density is the higher standard, and having it remove the lifts already completed with the three phases of the roller is an improper rejection.[3, p.130-131]

Changes in Methods of Performance:- it is known that unless a specific construction method is specified, the contractor is free to choose whatever he wishes. The vital point to remember in this circumstance is that the contractor must be ordered by the owner to use a certain method, if no method was originally specified, or ordered to use a different method if a certain method was originally specified. If these changes in methods prove to be more expensive, then the contractor will be compensated for his cost and time.[10, p.21]

Impossibility of Performance:- a term expressed when the performance specified in the contract documents can not be completed by any contractor. The job is impossible to perform according to the existing contract. For example; a requirement addressed to the contractor to use and to furnish materials, that are no longer manufactured, is grounds for impossibility of performance. There are times when the owner unreasonably insists that it is the contractor's obligation to manufacture the materials as specified. This occurrence should be documented and recovery should be sought under impossibility of performance.[8, p.71]

Defective Performance:- any fault or error of the company personnel that are not in accordance with the project plans and specifications. Defective performance includes both office and field work, such as materials are incorrectly ordered by the project manager in the office.[8, p.69]

Owner Non-Disclosure(sometimes referred to as "superior knowledge"):- any information which the owner has and may affect the contractor's method or manner of performance should be made available to the contractor. An example can be a contractor performing a contract for dredge and almost a rocklike. The material include cobbles and boulders that were not apparent from the information in the contract. When the situation is addressed to the owner, it represents a set of soil borings that show exactly the conditions encountered. Unfortunately, these borings neither had been made a part of contract, nor were they available to the contractor at the time of bid. This

was a constructive change of failure to disclose material information.[3, p.131]

Defective Owner- furnished property:- property provided by the owner must be adequate for the performance of the originally contracted work. Therefore, if the owner furnishes the contractor with defective property, material or equipment, the additional work required of the contractor to remedy the defects is compensative and gives rise to a constructive change.[10, p.23]

2.4 CHANGE ORDERS

A change order is a written agreement to modify, add to, or otherwise alter work from those that have been set forth in the contract documents at the time of opening bids, provided that such alternation can be considered to the scope of original project [9, p.459], otherwise a contract modification may be required.

Within the industry, any change in scope is referred to a "Change Order". This is wrong. It is not a *Change Order* until it has been approved by all parties. It is the only legal means available to change any contract provisions after the award of the contract.[11, p.229]

Although some professionals [12] ignore the change order process, it is a standard practice in construction contracts to allow the owner to make changes in the work after the contract has been signed, as well it is the contractor's only official vehicle for initiating documentation when there is, or has been, a change in the scope of work. In fact, a change order might even be referred to as a *mini-contract*. [10, p.16] As a consequence, they must be handled as called for in the contract and be well documented, including official approval or disapproval.

It is important to remember that every party involved in a project needs to use the change order process because it is the *only true* documentation vehicle that allows the manager to properly initiate, transmit and document a legitimate claim for any work above and beyond the scope of the contract. It may be the only way in which the managers can keep records meaning that something is happening on the

project that has been included in the scope of the original contract documents. For example; the owner/user or architect/engineer may not be willing to issue a field order for certain work that is beyond the scope of the project, but which must be accomplished in order to complete the project. In such instances, a claim should be documented by submitting a Change Order. This should be done promptly in order to establish the claim, so that later the owner/user or architect/engineer can not claim that the contractor was searching for ways to make an extra profit on the job after the project had been finished.[11, p.291]

Consequently, a change order is the formal document that alters some conditions of the contract documents and its specific clauses, such as changes involving *additions to, or deletions from the work, changes in the methods of construction or manner of work performance, changes in owner-furnished materials or facilities, or even changes in contract time or order of work.*

Each change order must be evaluated individually; however, there are certain basic principles that apply to management of all types of change orders.[9, p.462]

1. No work should be included beyond the scope of the base contract, particularly beyond public work contracts.
2. The identity of the individuals authorized to request and approve change orders should be established as early throughout the project life cycle as possible.
3. During the pre-construction briefing, a meeting should be held to establish the change order handling procedures.
4. All changes in the work must be specified in writing prior to the execution of any change.
5. The scope of a change order must be clear, and a request for a change should contain enough information to enable the contractor to make a realistic estimate of cost and time.
6. The contractor should submit its proposal to execute a change order as the earliest possible on receiving the request, and the owner's approval or rejection should follow right after.

7. The proposal should be fair. It should recognize the contractor's right to include overhead and profit percentages in change order estimates and in time and material change order billings. It should also be recognized that the contractor is entitled to compensate the legitimate time-delay claims, processing of deduct change orders, costs of the disposal of the removed material, and all other legitimate costs incurred in the execution of the change.

2.5 IMPACT OF CHANGES

It is a fact that any project plan will have to be changed before the project is completed, generally the larger and more complex the project, the large number of changes and the greater the deviation of actual costs and schedules from original objectives. But there is a reverse causality too: not only emergent project problems require the plan to be changed, but changes to plan cause problems to the project. In fact, changes to the project plan are a *chief* cause of cost and schedule overruns, low work morale, and poor relationships between project manager or functional managers, and clients.[13, p.397]

In general, changes have a *detrimental* effect on morale and efficiency and their effect is multiplied as the project proceeds. The more work that has already been done, the more that has to be undone. Whenever work has to be torn down or scrapped and repeated, labor morale is affected. People see their work being dismantled, discarded and redone, usually on a rush basis to try to reduce overruns. Consequently, this can lead to long-term effect that is beyond the *control* of the project team and that is immeasurable.[13, p.397-14, p. 201-202]

Another immeasurable impact of change is on relationships between the project manager or functional managers, and other managers and even clients. Because of their adverse effect on project cost and schedule objectives, project managers usually resist changes. As a consequence, excess number of changes and their impacts on project scope, cost and schedule are the common source of conflicts between project managers or functional managers, and clients and these conflicts worsen relationships among those involved.

The immeasurable impacts of changes can be expressed although project changes are not issued as change orders. Whenever a change is approved by all parties involved, the impacts of change must be defined in terms of:- cost and time, both of which have been the two major components of any change order.

Change Orders and Time

If no time is specified for the change, then this should be stated in the body of the change order. It is better not to leave the question of time for resolution at the end of the project. It might be useful to assess and resolve it contemporary with the change order process. The key variable, to reduce the impact of any change, seems to be the timing of the change.

The manager must assess the impact of time for every change, no matter how small it is. This assessment must be made both from the perspective of the current updated schedule and the standpoint of resources. For instance, the manager might review a change based on the schedule and note that it does not affect a critical activity. But a review of the resources involved shows that to perform the change, the contractor must utilize a specialized piece of equipment. This equipment is on the project site but is involved in performing critical work. If the contractor attempts to perform the change work, it will affect other critical activities by withdrawing the equipment to use on the change. As a consequence a delay might occur. After a careful study, the contractor notes that the change can only be performed after the critical activities are completed, and that in this revised sequence, a time extension is warranted.

Every possible impact of a change concerning the time on the project should be thoroughly considered. This includes not only the impact of a small change, but also the cumulative impact of numerous changes. For example; a contractor constructing a complex facility was issued several hundred change orders. Each change order by itself did not have a measurable impact on the time or schedule. Since most of the changes required pipefitter hours, however, there was a significant impact. Because of the location of the project and the unavailability of pipefitters, the cumulative hours required by the changes caused a significant delay. There was only

so much overtime that could be worked. Given the limited resource of pipefitters, a running total of the extra hours would have shown that the project duration would be extended. Unfortunately, the problem was not recognized after the project was delayed.

Change Orders and Costs

The costs involved in a change order are in variably addressed by all parties. How they are handled is a function of what the contract requires concerning cost. Most changes' clauses provide alternative costing methods such as:

- Established unit price
- A negotiated lump-sum amount
- Time and materials
- A decision by the Architect/Engineer

Practically, the better written the change clause, the fewer problems will occur in deciding on costs for a change.[3, p.135-136]

In using the established unit prices, the manager must be cautious to directly apply to change that is being initiated. For example; if a unit price was established for excavation and the owner now directs some additional excavation, it would seem obvious that the unit price should be used. However, if the original unit price was based on mechanical excavation on a large scale and this change requires hand excavation, the unit price might not be appropriate. The better defined the original unit prices are, the fewer controversies will arise. Similarly, the earlier use of directed clauses will be helpful in such a circumstance.[3, p.135-136]

Presuming no unit prices are applicable, the contractor will be required to submit a cost proposal for the changed work. Although only an estimate, this proposal should include a detail breakdown for labor, material, equipment, overhead, and so on. The owner should promptly review this and diligently work to resolve the change costs before the work is done. But as it is always noted, the contractor should be skilled at estimating, and thus

there should not be a problem as long as the extent of the change is clearly and completely defined.[3, p.135-136]

Some construction professionals maintain that using the actual cost of the work is better than the estimated cost. This philosophy directly causes a conflict. If the contractor waits until the work is completed to submit the bill, the owner may very well react: "I didn't know it would cost that much" or "If I had known that, I never would have directed the work" or "It couldn't have been that much-I'm not going to pay that." Now this is the major problem. The contractor has recorded the costs as actual costs and is not willing to negotiate the amount down. The owner refuses to pay what he believes is too much. The obvious outcome is some form of dispute and ensuing arbitration or litigation. The problem can be avoided by resolving the change before the work is performed.[3, p.135-136]

Using time and materials is an acceptable approach when the situation does not allow for resolution of the cost of the change before the work is performed. This should only be used when the work must immediately progress. Too many contracts slip into a lazy form of change order management by just using time and materials for all changes. Both the owner and contractor must aggressively work to resolve the change orders before the work is done. If time and materials approach is used, then the guidelines of the contract must be followed concerning what costs are allowable and how the information must be tracked and recorded. If the owner had the forethought to have a well-written changes clause, which should preclude any problems arising from time and materials types of changes.[3, p.135-136]

CHAPTER THREE:

PROJECT CHANGE MANAGEMENT

3.1 INTRODUCTION

The engineering and construction contracting environment is increasingly competitive and litigious, project schedules and financial parameters are aggressive, and project scopes are complex. Today's smaller, less experienced staffs and leaner budgets, however, often force owners and contractors to re-evaluate project execution plans. Nonetheless, those responsible for executing projects are expected to deliver high quality and cost-effective results. Projects thus are more likely to require changes in order to meet business needs or objectives.

Changes- additions, deletions, or other revisions within the general scope of a contract that cause an adjustment to the contract price and contract time- present a variety of challenges for every party to a construction project. Frequently, events on a project lead to an amazing divergence of opinion about what constitutes a change and about its impacts. Since a change may affect a variety of project outcomes in different ways for each party, this is understandable. Consequently, various terms for proposed changes- discretionary, non-discretionary, preferential, functional, normal design development, and regulatory- are often employed to establish or even shift responsibility. In change management, the absence of common terms and specific contract conditions can lead to dissatisfaction and litigation.

Project management teams must have the ability to respond to a change quickly and effectively. This ability to respond, however, is complicated by a variety of project organizations, project control systems, and work execution methods.

3.1.1 Effective Change Management

In order to overcome the problems associated with changes to a project, project teams must be able to effectively manage changes. For this reason, each project team is at first required to employ the five principles of effective change management, starting with “promote a balanced change culture”. And in fact a balanced change culture can only be created by taking three steps. First, a *commitment* by all parties must be reached to *recognize* the need for changes and to increase *sensitivity* to changes as the project progresses from concept to construction. Second, *planning* for *potential* changes should be initiated as early in the project as possible. Third, all parties to the project should agree that changes are to be *evaluated* and agreed upon as *expeditiously* as possible.

Taking this access will require the project team to apply the scope of the research-*principles of effective change management*.

1. Promote a balanced change culture
2. Recognize change
3. Evaluate change
4. Implement change
5. Continuously improve from lessons learned.

Each phase of a project should have established change management procedures consistent with these principles. As the project moves forward, the procedures will have to address increasingly detailed matters and must establish more finite control.

This section focuses solely on the construction phase; that is, since changes in the construction phase often have a major impact on project success, introducing change as early as possible in the project life cycle is a proven advantage.

3.2 PHASES OF THE PROJECT LIFE CYCLE

To manage project change, the evolution of a project through the different phases of the project life cycle must be understood. The figure 3.1 below indicates the flow-through of the various phases of the project life cycle. These phases often overlap and vary in duration. Each phase is a work process, with specific input and output relationships with the other phases. This section describes each phase and concludes with a discussion of the interphase agreements.[4, p.3 -7, p.3-6 -12, p.13]

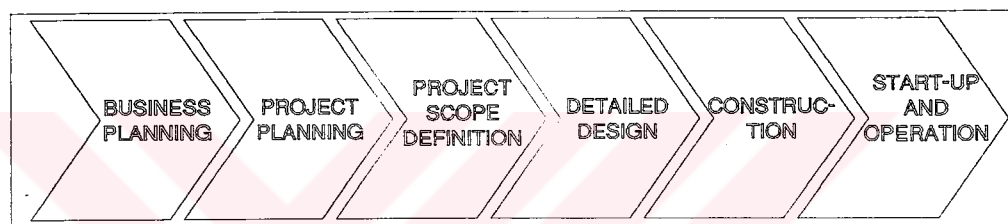


Figure 3.1 Project Life Cycle

3.2.1 Business Planning

The first phase of the project life cycle is business planning. The business planning phase of the project life cycle links the strategic business goals with initial project goals. The owner leads this process, producing the capital investment business objectives and the justification for the facility.

During this initial phase, the owner's marketing and other business functions define the need for the facility and estimate its financial return. Marketing, as part of the overall development team, normally supplies written business objectives for the facility. Engineering and operations of the project provide early estimates of both initial and operating costs. Considering similar, previously executed projects, a rough economic model of the venture, including a preliminary scope definition, major risks and rewards, and cost estimates can be completed. If the initial economic model indicates a favorable return on investment, the project will proceed to project planning.

3.2.2 Project Planning

In the project planning phase, the owner uses the basic business objectives to develop a scope of work for the project. The scope should be sufficiently developed to define acceptable project risks and funding requirements for the ensuing phases. Although not all of the design questions will have been settled at this point, the basic information such as facility size and capacity will be decided upon during project planning.

Different industries, and even different owners, will formulate their own guidelines of what constitutes *sufficient* scope definition and *acceptable* risk. Some owners will only partially fund the project at this point, requiring the project team to reconfirm project cost and schedule after conceptual engineering has been completed.

In the project planning phase, a high level of experience in project estimating, planning and design is required. Many owners maintain this expertise themselves to assure sound business decision. Owner engineering and construction organizations usually lead the project planning phase, assisting the business organization in decisions concerning the project's basic scope and timing. Some owners, however, employ planning consultants.

During project planning, ideas and suggestions from those who will operate and maintain the facility can help to minimize changes as the project moves forward.

3.2.3 Project Scope Definition

During the project scope definition phase, all the basic design decisions are made, including adaptation of the facility to the selected site, incorporation of local codes and standards, and further detailing of the facility. The project scope is documented in drawings, sketches, items lists, and text. Project documentation produced in this phase is usually sufficient for estimating material quantities accurately enough for project control.

Even though the owner makes all the fundamental decisions in project scope, a designer may be hired to create scope documentation to quantify the detailed design of the facility.

Constructability analysis at this stage is invaluable in that it can help the project team to minimize changes as the project moves closer to construction.

3.2.4 Detailed Design

During detailed design, the documents for fabrication of components and the construction of the facility are produced for the suppliers and constructors. Detailed design is typically performed by an architectural and/or an engineering design firm. Engineered materials and equipment are often procured in this phase or earlier.

3.2.5 Construction

The construction phase of the project life cycle involves the fabrication of permanent components and the construction of the facility. Construction may be managed by the owner, by a construction management firm, or by a general contractor. Regardless of the division of responsibility at the owner's level, much of the actual work in the construction phase may be performed by the specialty subcontractors and suppliers, whose scope is defined by individual subcontractors.

3.2.6 Start-Up and Operation

During the start-up and operation phase of the project life cycle, the facility operator assumes the care, custody, and control of the completed facility. In the process industries, this phase would include commissioning activities and plant acceptance procedures. This facility only begins to achieve its business purpose once operations commence.

Agreements: The Inter-Phase Relationship- As the project moves from phase to phase and overall control and leadership move from one entity to another, various agreements are reached to assure orderly execution of work. An effective change management process recognizes change as a *modification to an agreement between project participants*. Figure 3.2 [4, p.5] shows the project life cycle and the ever-increasing complexity of these agreements.

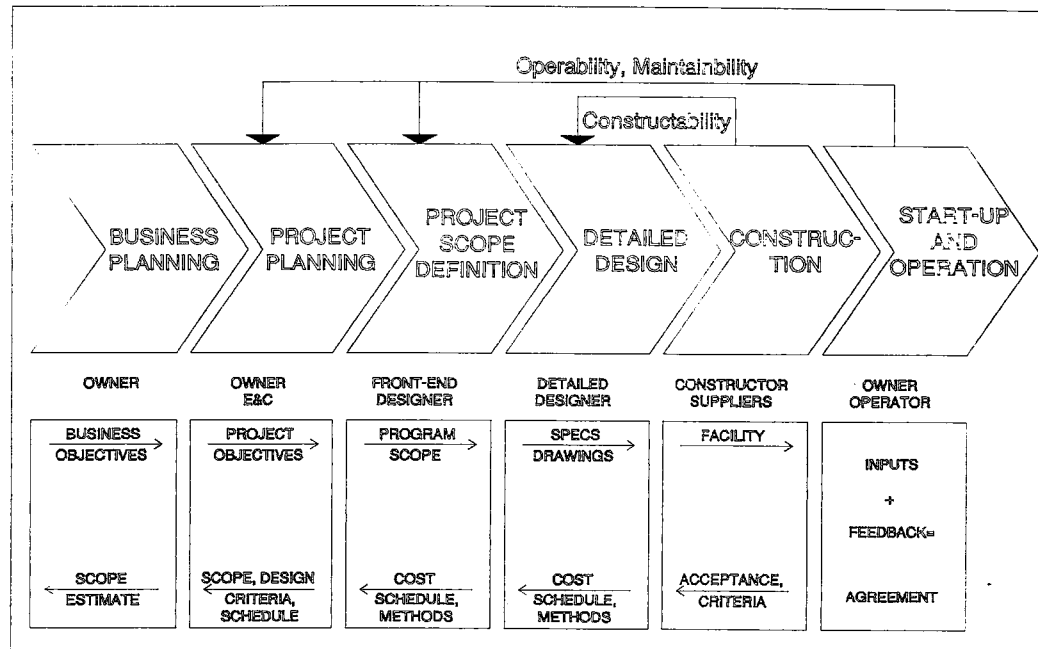


Figure 3.2 Project Life Cycle, with inter-phase relationships

These agreements consist of inputs (requirements) and feedback (how the requirements will be satisfied). The communication of inputs and feedback must be clear, complete and understood. If not, the agreement will be flawed and one or both parties to the agreement will be dissatisfied.

Another difficulty in an evolving project is that the “upstream” party to an agreement often defines the project in less specific terms than does the “downstream” party. That is, the upstream party defines *what* it wants, but is less involved *how* the downstream party provides it. The downstream party responds with a solution to the problem *how* it will accommodate the desires of the upstream party. The communication that occurs here is extremely complex and may be easily misunderstood.

For project agreements to be completely understood by all parties, obstacles to communication must be acknowledged and bridged. Just as the designer has the responsibility to the contractor to produce clear and complete drawings, the contractor has a responsibility to the designer to seek clarification when questions arise. Many problems in the engineering and construction industry occur because one party does not sufficiently

understand what is required by another party, yet it acts anyway. This situation can rapidly consume time and money in addition to producing detrimental end results.

Just as a variety of *agreements* is made on a project, a corresponding variety of *changes* is also made. Even when agreements are clear and well understood at one level, they continue to be made at varying levels of detail, thus making their meaning difficult to understand.

One example is project scope definition. For the owner, project scope is broader and is framed in different terms than that of, for example, the scope of the painting contractor. If the painting specification for a building is changed, this is definitely a change to the painting contractor. The owner, however, would not consider this a change because the building size and nature have not been materially altered.

Because *change* can best be understood in the context of *agreements*, a critical skill for project managers is the ability to discern whether an agreement actually exists. By having a change management process in place, a project manager will be able to better understand the complexity of the project and to better communicate with all project participants.

Agreements and Organization- Agreements are made at many levels of a project, just as teams are organized at many levels. The agreements become more specific and detailed as the organization is filled out with all the work teams. Likewise, change can be introduced at any level, possibly requiring the restructuring of many related or collateral agreements. A key to effective change management is maintaining a broad view of all of the agreements on a project and constantly testing the completeness and quality of these agreements.

3.3 DYNAMICS OF CHANGE MANAGEMENT

Changes occur during the development and execution of projects for a variety of reasons. Regardless of the type and magnitude of a change, complex dynamics result. The complexity created by change increases as the project moves through the different phases. To ensure that the expected project outcomes are achieved, it is necessary that project execution include a change management process that will deal with these complexities and minimize interference and disruption of the project execution plan.

The elements of a project that are subject to change and that will affect the change management process are:[4, p.7-10]

- Project Scope
- Project Organization
- Work Execution Methods
- Control Methods
- Contracts

Changes to these elements will have different effects during various project phases. In addition, the interaction of these elements becomes significantly more complex as the project proceeds.

Change management should vary with the type of project, the project phase, project agreements and contracts, and project schedule. An effective change management process should allow for the complex dynamics that will likely develop, and should provide a disciplined approach for recognizing, evaluating, and implementing changes in a timely and cost-effective manner.

3.3.1 Project Scope

As used here, project scope includes content and parameters, schedules and milestones for execution, budgets, and expected project outcomes. Project scope is the major determinant of the cost for a project. Thus, scope changes will both have significant and direct impacts on project cost. Even the value of beneficial

changes to project scope will be diminished because of the effects of the disruption that they create. The negative effects of scope change will increase rapidly as the project progresses from business planning to start-up. Even incremental change can have disproportionate impacts due to indirect and cumulative effects.

In terms of quantifying the cost of changes, the effects on productivity frequently are unrecognized by current change management practices. The effects of change on productivity has been the subject of an earlier research performed by the Construction Industry Institute (abbreviated as CII) Contracts Research Team. It concluded that projects with a high degree of change experience lower productivity (see Figure 3.3). On projects with less than six percent of hours spent on changes, productivity was better than planned. This indicates a need to consider the total effect caused by an environment of excessive change.[4, p.8]

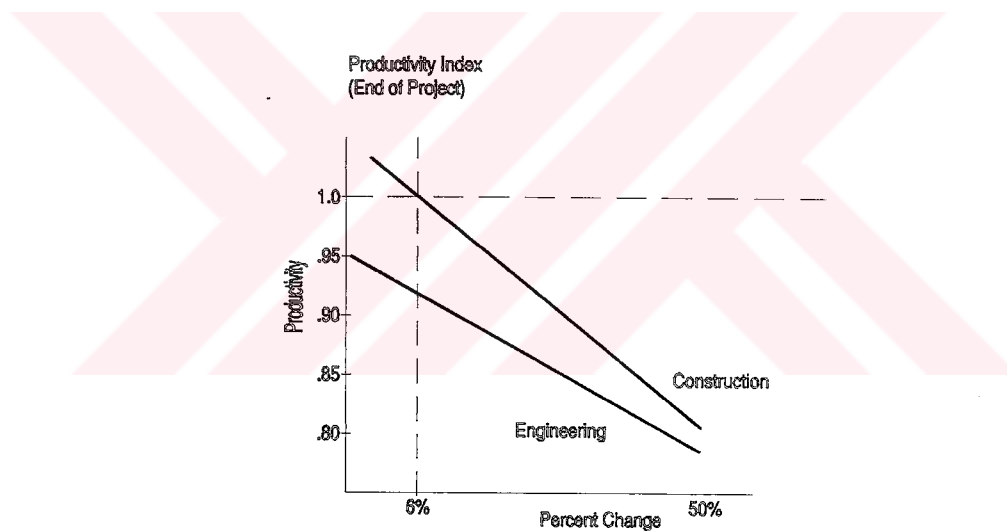


Figure 3.3 Effects of change within phases. Productivity declines with regards to changes within phases of a project.

3.3.2 Project Organization

The project organization involved in the execution of any project phase will affect the management of change. Additionally, organizational changes themselves represent a project change. Such changes can relate to structure, interfaces, hierarchy,

personnel assigned to the project and their skill level, experience and behavioral characteristics.

To be effective, the project team must have the capability and disposition to manage change. This must be done in a manner that provides the desired results with minimum negative impacts on the project and on all involved with its execution. The organization needs to include personnel who have experience and discipline in recognizing, evaluating and implementing change. The organizational structure and hierarchy must clearly identify the responsibility, accountability and empowerment for managing change. Most importantly, the team must make decisive and timely decisions concerning proposed changes and must effectively communicate the decisions to team members and others who have a stake in the project.

Project organizations should include a balance of innovators and implementors, should promote teamwork and collaboration, and have a disciplined approach to executing projects. Effective change management should be established as a project success factor for organizational, team and individual performance.

Changes in the project organization must be made in a calculated manner, and should consider the possible impacts on project execution.

3.3.3 Work Execution Methods

Work execution methods, as used here, are all the processes, methods, systems and procedures used by those involved in the execution of projects.

Effective management of change requires the use of work execution methods that include specific, integrated and systematic steps to recognize, evaluate and implement change. Work methods, including the management of change, should be standard, proven, known to those utilizing them and understood and accepted by those that interface in the execution of the work. Importantly, work execution methods should allow for and accommodate change appropriate for the degree of definition and certainty that exists for any particular project phase.

A change in work execution methods from those planned or being applied can represent a project change. When such changes are being considered or are found to be necessary, the impact on the project must be evaluated, the same as any

other change, including both direct and indirect impacts. Particular consideration should be given to the products, timing and quality produced by the work methods and what impact these will have on users, both internal to a project phase and between two or more phases.

3.3.4 Control Methods

Project control methods, as used here, are budget controls, schedule controls, trend analysis, status reports, progress reports and other methods employed to monitor project performance against established benchmarks. Similar to work execution methods, the control methods used in managing changes should be standard, known to those utilizing them and understood and accepted by those involved in the project.

Effective control methods allow for proactive management of change. Project controls, therefore, should be appropriate for the type of project and the project phase. Such controls should make specific provisions for identifying and quantifying project changes. In particular, project controls should be capable of reflecting the cumulative effect of “minor” changes. Individually, such minor changes may be considered manageable, but may cause unexpected cost and schedule impacts because of the complex nature of projects.

Furthermore, the control baseline should be mentioned throughout the project in order to provide the project management with consistent tracking of deviations and changes. Changing the project control baseline during the detailed engineering/construction phase can cause a lack of confidence in the control system and a loss of team discipline. Then, rebuilding should only be done in extreme circumstances involving established overall changes in a project.

Control methods for project changes should be appropriate for the magnitude, nature, timing and assessed impact of the change. Disproportionate control of changes can lead to delays and unnecessary additional work, which likely will have an adverse effect on project execution.

3.3.5 Contracts

The types of contracts and the allocation of risks in place during the execution of a project can have a significant impact on project change management and project success. These factors also may affect the attitudes and behavior of the people involved in project execution via ways that inhibit the proper recognition, evaluation and implementation of change.

Contracts, agreements, guidelines, and responsibilities, preferably in written form and mutually accepted by all parties involved, should always be in place. These may vary in form and content depending on the phase of the project, the number of organization, groups and individuals involved, the nature of the work being performed, the level of definition available and the accuracy of the data serving as the baseline. The absence of such contracts and agreements frequently leads to problems in the effective execution of work, and will be particularly problematic in the management of change.

Verbal agreements, understandings or directions can be easily misinterpreted, miscommunicated, or even ignored. While appropriate in some circumstances, they should be avoided. Or, at least, the pertinent understanding from verbal agreements or directions should be confirmed and communicated in writing.

3.4 PRINCIPLES OF EFFECTIVE CHANGE MANAGEMENT

This section presents the principles of effective change management that have been identified by the research. Using and understanding these principles will facilitate the *success* of any project.

The principles of effective change management are:[4, p.11-22]

- Promote a balanced change culture
- Recognize change
- Evaluate change
- Implement change

- Continuously improve from lessons learned

Ineffective change management is often similar to spinning a pinwheel.(see Figure 3.4) [4, p.11]

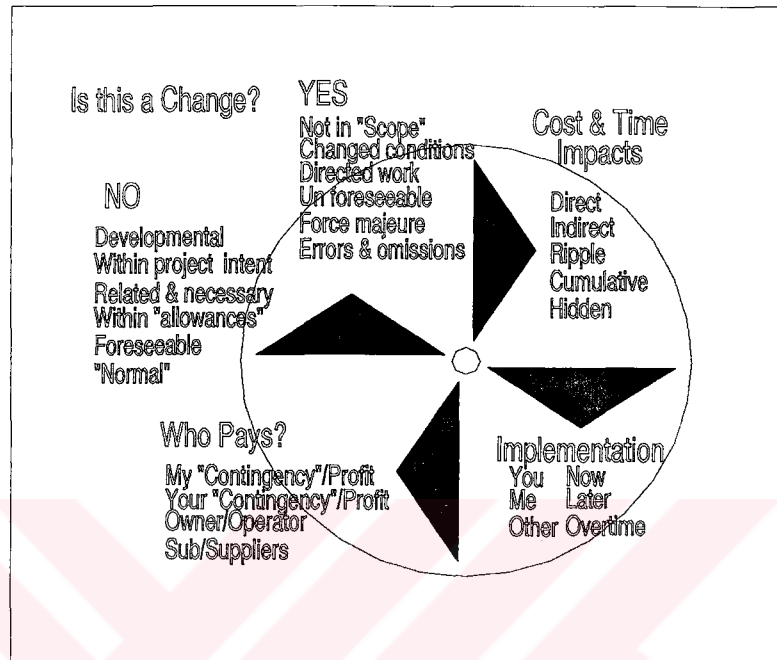


Figure 3.4 Ineffective Change Management

The scope is to straighten out the pinwheel so that the process flows forward instead of in an unending circle.(see Figure 3.5)

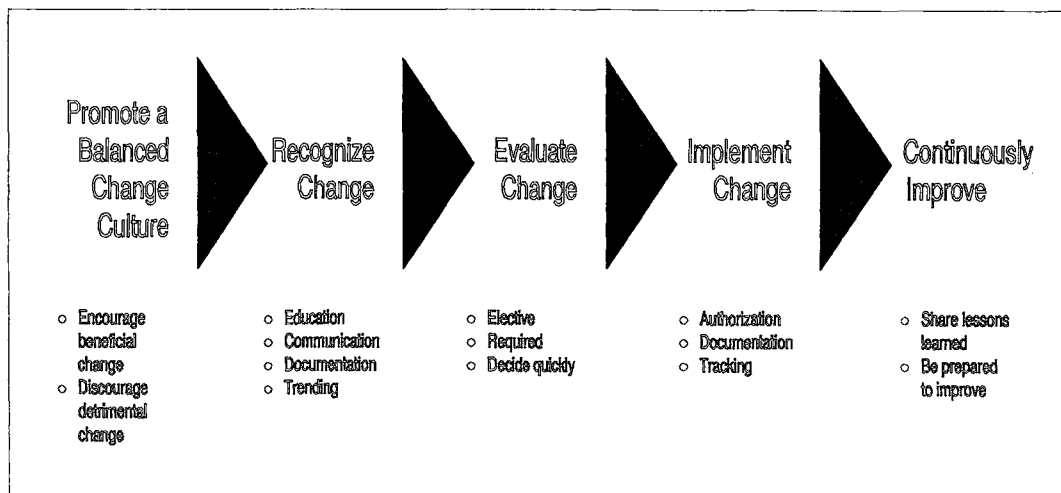


Figure 3.5 The Principles of Effective Change Management

3.4.1 Promote a Balanced Culture

The first principle of effective change management is to promote a balanced change culture. Doing so will allow changes to proceed, as a result of which the project end user will clearly benefit from. Conversely, it will discourage or prevent adoption of changes that do not meet this criterion. The research labels these as “beneficial” and “detrimental” changes, respectively. These distinctions are frequently difficult to agree upon because what is beneficial to one party may be harmful or detrimental to another. Thus, the allocation of costs and benefits should be made equitable and consistent with the base agreements in place.

Regarding this point-of-view, at this very point it is vital to define what is beneficial change and why it should be encouraged; whereas it is also vital to identify the detrimental change and its impacts.

Encourage Beneficial Change. Changes that can actually help reduce cost, schedule, or degree of difficulty- are to be encouraged. Encouragement means that the door to change is open. Beneficial means not only immediate and positive impacts, but also that no long-range negative impacts will occur. Sometimes immediate beneficial change means potential long-term problems.

This situation can build resistance to change of any kind. Beneficial change creates an environment for making continuous process improvements. However, in reality, project inertia can make implementation difficult. Therefore, in order to prevent from this threat, *the following points should be clarified regarding beneficial change:*

- Critical project success factors must be documented and communicated to all parties (e.g., those that improve cost, schedule and so forth).
- Timely and accurate predictions of the cumulative impact of a change are particularly important since changes are sometimes implemented in the belief that they will be beneficial, only to discover later that unforeseen costs or complications made it a poor decision.
- Anticipate change when allocating time and resources are to a project. If this is not done, change will not be managed well and the project will suffer.

- Recognize and reward those who initiate beneficial change.

Prevent/Discourage Detrimental Change. Detrimental changes are those that reduce owner value or have a negative impact on a project. Such changes are not always recognized as detrimental until they have already caused some sort of problem.

Detrimental change usually has a lasting effect, and tends to make the team resistant to the change process. It may even inhibit the recognition of change. Detrimental change also may occur due to lack of alternative solutions to a problem. As the project moves from business planning phase toward start-up, change, specifically detrimental change, becomes more costly.

There are certain *effective management techniques* to be employed in order to *prevent/discourage detrimental changes*. Such techniques are briefly explained below:

- A formal value engineering system can provide good guidelines for change management.
- Structure the analysis and understanding of what constitutes detrimental changes.
- Require financial justification for all elective changes.
- Maintain accountability for any change being introduced.

3.4.2 Recognize Change

The second principle of effective change management is to recognize change. Therefore, it is important that an environment, that allows team members to openly communicate with each other, is created. The original agreements must be recognized as a baseline so that measurements and tests can be conducted to determine whether a change has occurred. Also, team members must understand the total overall effect a change may have on the downstream phases of a project. Such effects are seldom known when a change is initially recognized. Open discussions and better team communications will allow change recognition as early as possible.

A common disagreement between parties on a project is what constitutes a change. Thus, the effective definition of the scope of work is of paramount importance to identify and manage change. The scope must be tied back to agreed upon schedules, budgets, commitments, and accountability of recognizing change which is rather essential.

A skilled manager should create his own *effective ways to enhance change recognition*. Below is a list of ten basic ways to approach to the issue.

- Education: train all key team members in the importance of early identification and use of change management.
- The project team should flowchart its change management process and modify it as the need arises.
- Devote specific time at regularly scheduled meetings to identify and act on changes.
- Develop a formal, inhibited system to identify and handle change early in the project life.
- Have a specific list of definitions that everyone understands and agrees with.
- Require every change to be understood and evaluated.
- Use team building early in the project as a method to develop better communications in change management. Avoid hidden agendas; everyone should have the same information.
- Review previous changes regularly and determine whether anything has deviated from what was predicted.
- Regularly examine the total number and value of changes and their cumulative impact on the project.
- Ensure timely notice to provide affected parties with the opportunity to evaluate alternatives to a proposed change.

3.4.3 Evaluate Change

The third principle of effective change management is to evaluate change. One of the first steps should be to classify the change as *required* or *elective*, since each type will be evaluated differently.

Required Changes. Required changes must be implemented, and must typically include changes, that:

- are necessary to meet the basic, defined venture/business objectives.
- are necessary to meet regulatory or legal requirements.
- are necessary to meet defined safety and engineering standards. These types of changes are mandated, and the project team must determine if the project remains viable.

When a required change is identified, the immediate focus should be on effective implementation, which may include a study to select the best technical solution. Evaluation of the impact of the required change should proceed in parallel with its implementation.

Elective Changes. Elective changes are those that are proposed to enhance the project, but are not required to meet the original project objectives. Elective changes, therefore, are those that may or may not be implemented. This type of change is not mandated. Any number of reviews can be made and many questions can be asked. Also elective changes are normally considered to be beneficial, but long-range effects again should be considered and investigated. Although a change may be elective, deferred implementation may reduce effectiveness.

The cumulative effect of multiple changes, especially the effect on schedule, is extremely difficult to monitor or to calculate. A research carried out by CII Contracts Research Team indicates the ability to recover schedule once it has fallen behind. As also presented with the Figure 3.6 projects that are trending late tend to finish late, and the ability to recover diminishes with time, frequently due to ongoing changes.[4, p.16]

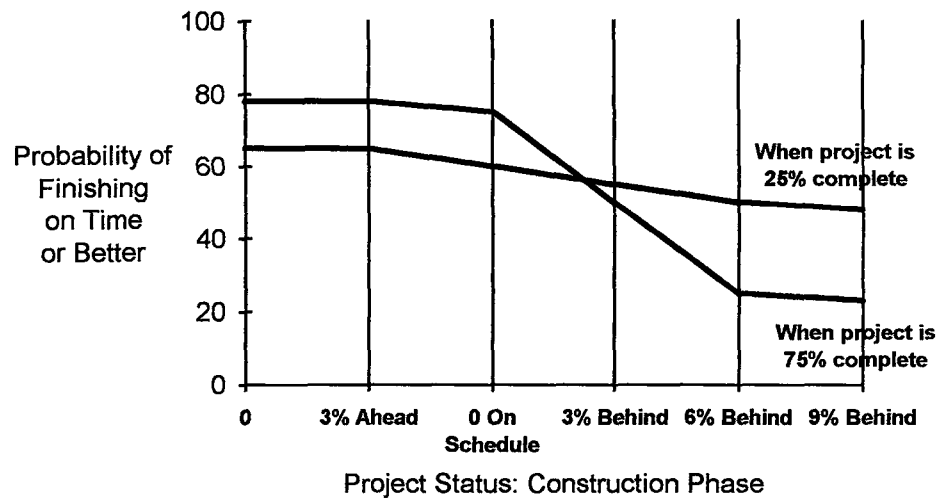


Figure 3.6 Probability of Schedule Recovery

The elective changes might be evaluated through the employment of some managerial aspects, clues of which are given below:

- After an elective change is evaluated, the immediate focus should be on the decision of whether to implement it. This will require a reasonable order of magnitude estimate of the impact of the change and a similar measure of the benefit of change.
- In order to determine if an elective change should be implemented, economic guidelines should be pre-established to guide the decisions makes.
- The decision to proceed should be made as soon as the decision maker is assured it will meet the criteria established for elective change.
- Caution must be exercised in making quick judgments in favor of implementing elective change, as secondary effects of making a change in one area can often impact another area.
- Guidelines for change implementation must be clear and consistent with the project's critical success factors.

3.4.4 Implement Change

The fourth principle of effective change management is to implement change. The project team must be flexible enough to be able to implement a change at any point in the project schedule. Early investigation of the total impact of the pending change should be made to inform the team of the impact of the change on cost and schedule. At this point, one should know that the change has been recognized and categorized as either beneficial or detrimental, and judged as required or elective.

Implementation results should provide sufficient information to evaluate the resulting value of the change, at least as it pertains to cost and schedule.

Authorization. There should be a process agreed to early in the project for approving identified changes. Authorization assures that all parties have been communicated with regarding the change. It also means that the change must be or can be implemented, and that all items that are required prior to implementation have been met.

Documentation. The change management process should include a documentation system that adequately tracks the items and their flow through the system. This documentation system should contain a method to follow up on the overall impact of the changes. The system can be simple, but should provide adequate insight into the change and its total impacts.

Frequent status updates will provide better knowledge and control of changes. Field reports during implementation are also helpful if changes are being evaluated in that area.

This research shows that systems are needed within the industry to generate and take advantage of a learned database. *Project final reports should have a section dedicated to the discussion of changes and their effect on the project and lessons learned.*

Tracking. Each change should be individually identified to allow consistent tracking through the life of the change. The total number of changes are not as important as their impact and effect. Tracking is valuable when the team desires information on the timing aspects of the change process. An

adequate tracking system also provides emphasis from the beginning to the end in order to complete the changes.

Consequently, in order to implement change the following points should primarily be remembered.

- The industry can only continuously improve its management of change by measuring and analyzing changes and its impacts on the project.
- Little emphasis is placed on making sure that lessons learned on an individual project are communicated to the broader organization and to project teams that are in the formation stage.
- The corporate organization must formulate a plan to collect data from all projects on the significant variables associated with change management and follow up to assure that the data is continuously collected through the course of projects (not just assembled).
- By enforcing consistent measurement, each organization can learn important lessons about how to manage and anticipate problems, and what corrective actions have proven to be effective.
- By establishing a consistent program of change metrics and shared data, the industry can convert its understanding of project change from a series of individual anecdotes to a body of knowledge that is useful in training the novice and can broadcast the successful innovations of skilled managers.

3.4.5 Continuously Improve from Lessons Learned

The fifth principle of effective change management is to continuously improve from lessons learned. From the outset, project strategies and philosophies should take advantage of lessons learned from past, similar projects. Thereafter, over the course of the project, the parties should agree to openly discuss problems arising from management of changes and opportunities for improvement. Metrics should be developed and employed. Targets should be adjusted to remain meaningful if necessary. The process should benefit the project at hand and document lessons learned to continuously improve future projects.

3.5 Conclusions

The only thing certain on any project is that there will be changes occurring along the way. Thus, all parties involved in the project should be aware of each single cause and impact of this inevitable element of the successful management of any construction project in order to control the risks associated with the projects' performance.

As a result of their detrimental effects, project teams resist changes and always view them as the impediments to progress. Even though the impacts of changes on cost, schedule and productivity and other project outcomes might be the significant project problems, project teams do not place sufficient emphasis on the management of changes. That is the reason why this research concludes that changes to any project are not the impediments to progress- in fact, each of them creates individual opportunities to improve; as far as project teams cope with them in such a way that certain beneficial outcomes are achieved in the end. The stated objective requires project teams to be educated, alert to change and tenacious in the pursuit of resolving them as quick as possible. Obviously, any failure in this area can lead to disputes in which all parties may lose.

As a conclusion, project teams must be keenly aware of changes and must employ the principles of effective change management which will enlighten the way to handle them via setting up a Change Management System (abbreviated as CMS) which will be explained in detail throughout the preceding chapter.

CHAPTER FOUR:

A Change Management System for Use in Construction

4.1 Development of a Prototype System

This research indicates an abundance of change control methods in use, with large amounts of information being collected. In analyzing these methods and information, the author recognized a great need for a *broad-based* change management system. The result is the prototype CMS outlined in this chapter, which is founded on the change management principles contained within Chapter 3. This prototype CMS is initiated to be a tool to assist project managers to manage change more effectively.

The prototype CMS is presented in outline and flowchart format. It is composed of multiple levels of flowcharts (the flowcharts of the system is shown in Figure 4.1), within two levels included in the prototype:

- A level one or “macro” flow chart showing the five change management principles necessary to manage change.
- A series of level two flow charts that show the specific activities involved with each of the level one or “macro” functional activities.

Each project will need to tailor this system to its specific circumstances. It is anticipated that tailoring will be done at level three and beyond. For this reason, a CMS with only levels one and two are contained within the prototype.

The level one and two activities are those should be contained within any CMS. The details of how change management systems are developed for three and beyond will be dictated by specific requirements and needs of the parties involved.

The prototype CMS assumes the responsibilities for level one activities as listed below.

Activity 1.0 Promote a Balanced Change Culture -project manager and key project members designated by the project manager.

Activity 2.0 Recognize Change -the originator or “champion” of a change.

Activity 3.0 Evaluate Change -selected project team members as called for in the CMS.

Activity 4.0 Implement Change -the project team.

Activity 5.0 Continuously Improve from Lessons Learned -driven by corporate and parent organizations, but performed by the project manager and key project manager and key project members designated by the project manager.

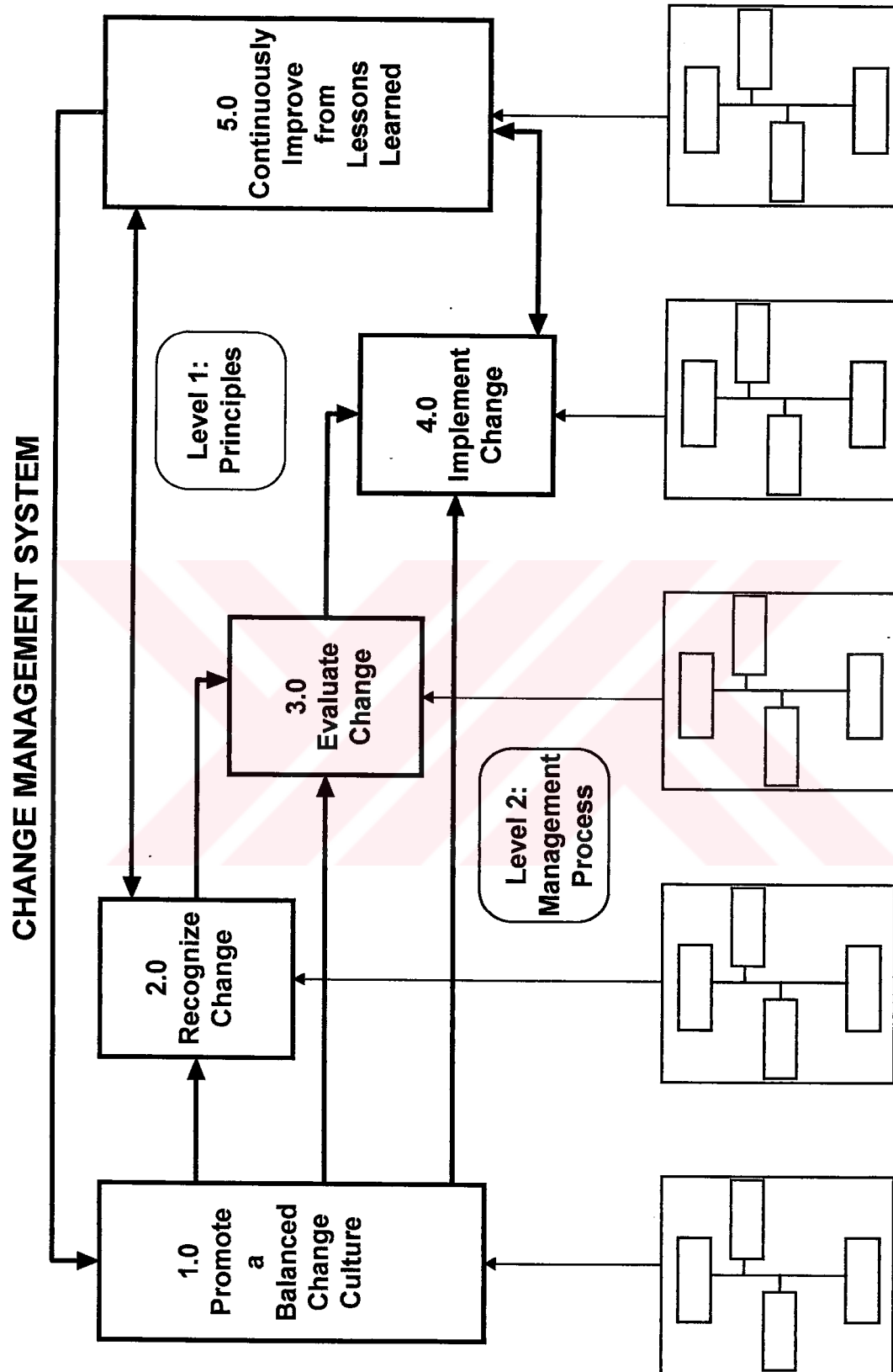


Figure 4.1 The Graphical Representation of the CMM.

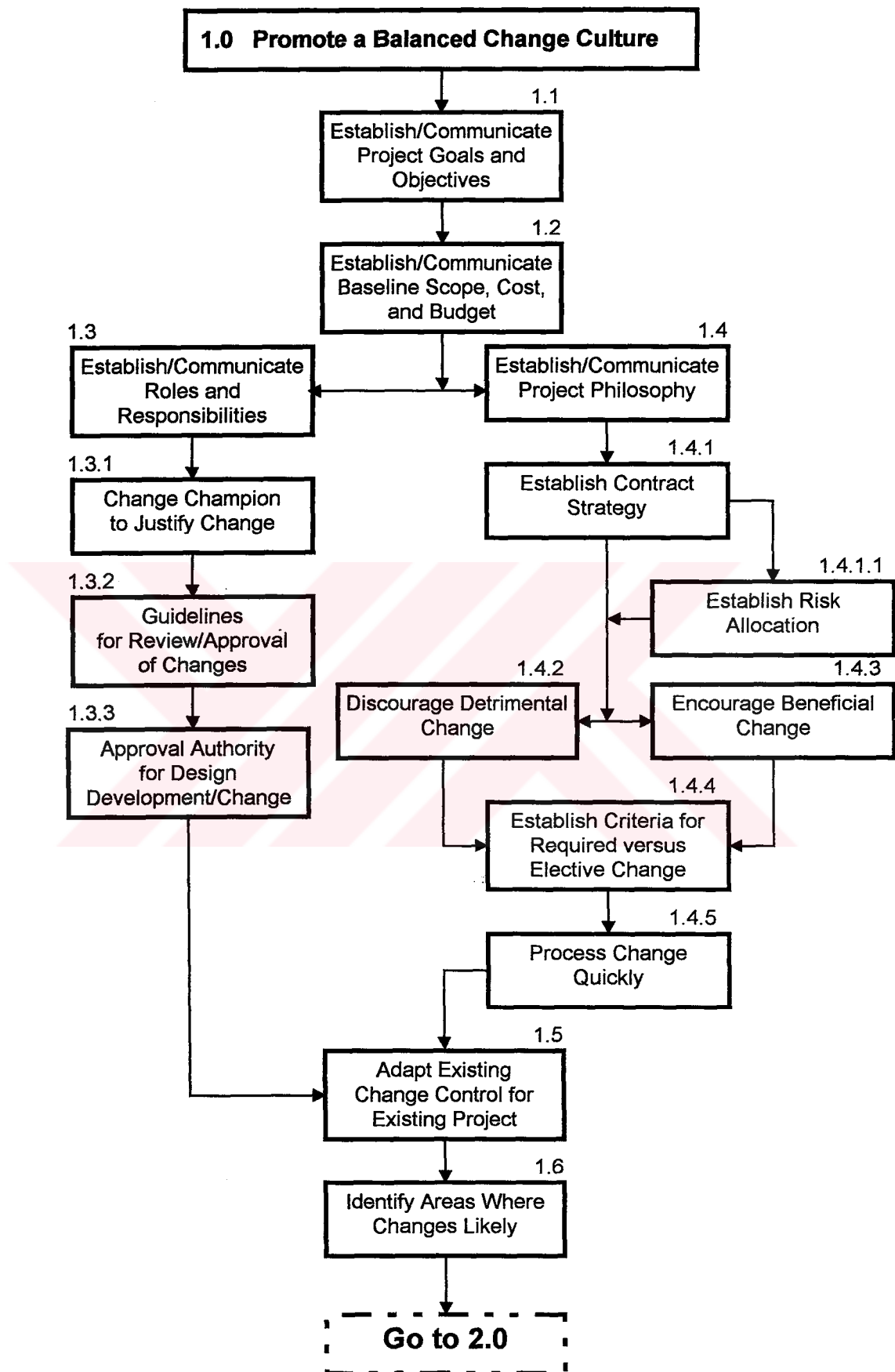
4.2 System Description

The *Change Management System for Use in Construction* consists of the following five activities:

- i. 1.0 Promote a Balanced Culture
- ii. 2.0 Recognize Change
- iii. 3.0 Evaluate Change
- iv. 4.0 Implement Change
- v. 5.0 Continuously Improve from Lessons Learned

1.0 Promote a Balanced Culture:

- 1.1 Establish, document, and communicate project goals and objectives.
- 1.2 Establish, document, and communicate project baseline scope, cost and schedule.
- 1.3 Establish, document, and communicate individual, organizational, and corporate roles and responsibilities for:
 - 1.3.1 The change originator or “champion” to justify the identified change
 - 1.3.2 Reviewing and approving change guideline.
 - 1.3.3 Approval of design development and for approval of change.
- 1.4 Establish and communicate project change philosophy to:
 - 1.4.1 Establish a contract philosophy that is fair and understandable to all parties.
 - 1.4.2 Encourage beneficial change.
 - 1.4.3 Discourage detrimental change.
 - 1.4.4 Establish the criteria to determine a required versus an elective change.
 - 1.4.5 Identify and process change quickly (i.e., timeless over precision).
- 1.5 Adapt existing change control procedures to suit current needs.
- 1.6 Identify areas of uncertainty or risk where change may likely occur.



2.0 Recognize Change:

2.1 Identify and document the potential change

2.1.1 Describe change

2.1.2 Identify the basis for the change

2.1.3 Categorize the type of change

2.1.3.1 Required change?

2.1.3.2 Elective change?

2.2 Assess potential impacts (preliminary and order of magnitude) and compare them to the baseline agreement. Here the effort should be comprehensive in scope, but not necessarily precise. The accuracy of the estimate is not important as the quick identification of all areas of potential impact. Final detailed impacts will be performed within Section 3.2.

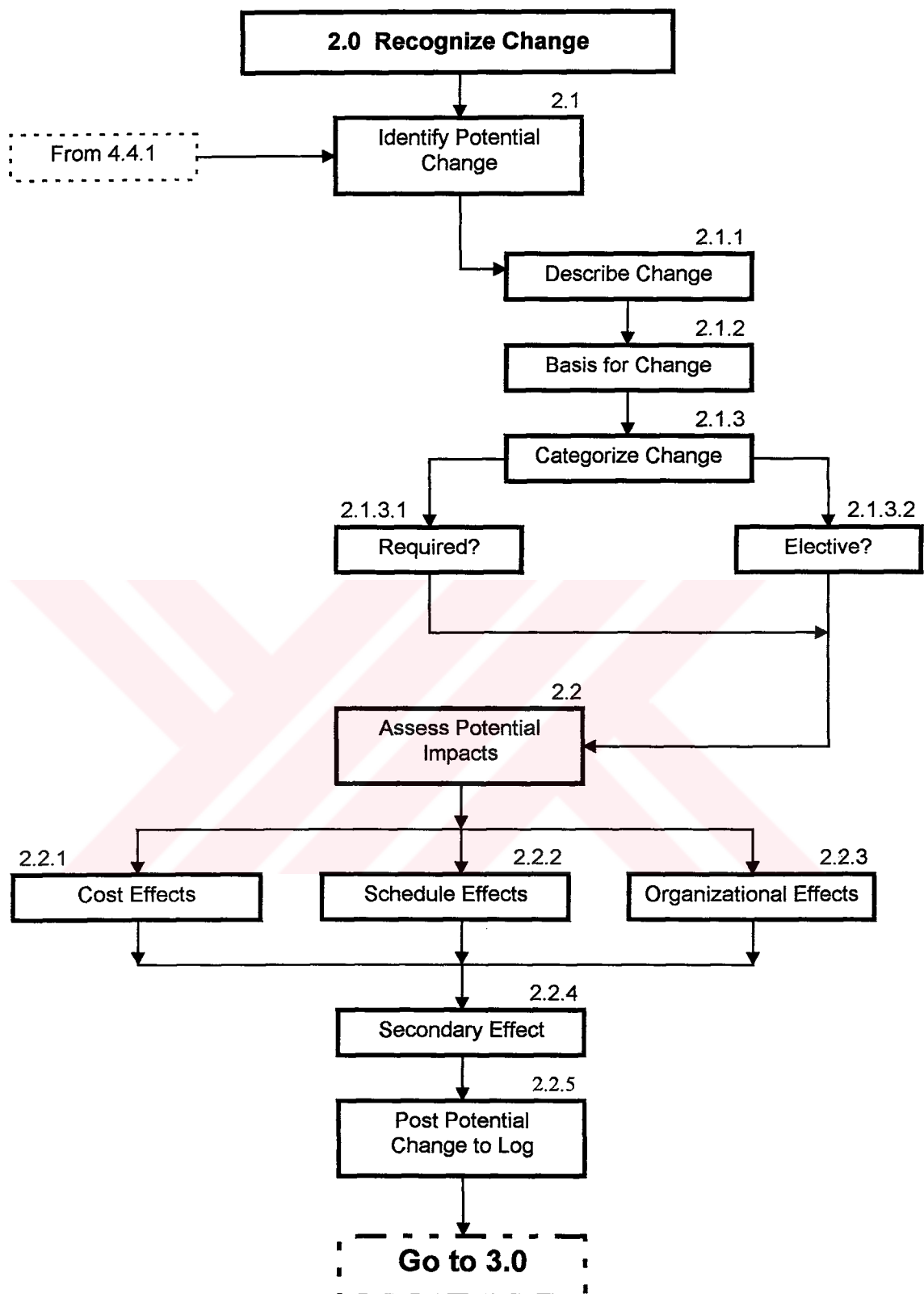
2.2.1 Assess effects on cost.

2.2.2 Assess effects on schedule.

2.2.3 Determine effects on other disciplines/ functions/ organizations.

2.2.4 Carefully review indirect/ ripple/ secondary effects.

2.3 Post the potential change to register or log.



3.0 Evaluate Change:

3.1 Determine the time frame for change decision.

3.1.1 Immediate or high priority decision required? If not, process through routine measures.

3.1.2 Determine funding source for handling internal approval of a high priority change decisions.

3.2 Collect data needed.

3.2.1 Conduct a thorough analysis on cost, schedule, quality, safety, resources, and other items. Evaluate on both direct and associated indirect cost.

3.2.2 Propose and evaluate alternative solutions and options.

3.3 Identify impacts.

3.3.1 Finalize impact on cost and schedule.

3.3.1.1 Primary impacts.

3.3.1.2 Secondary (indirect/ ripple/ cumulative) impacts.

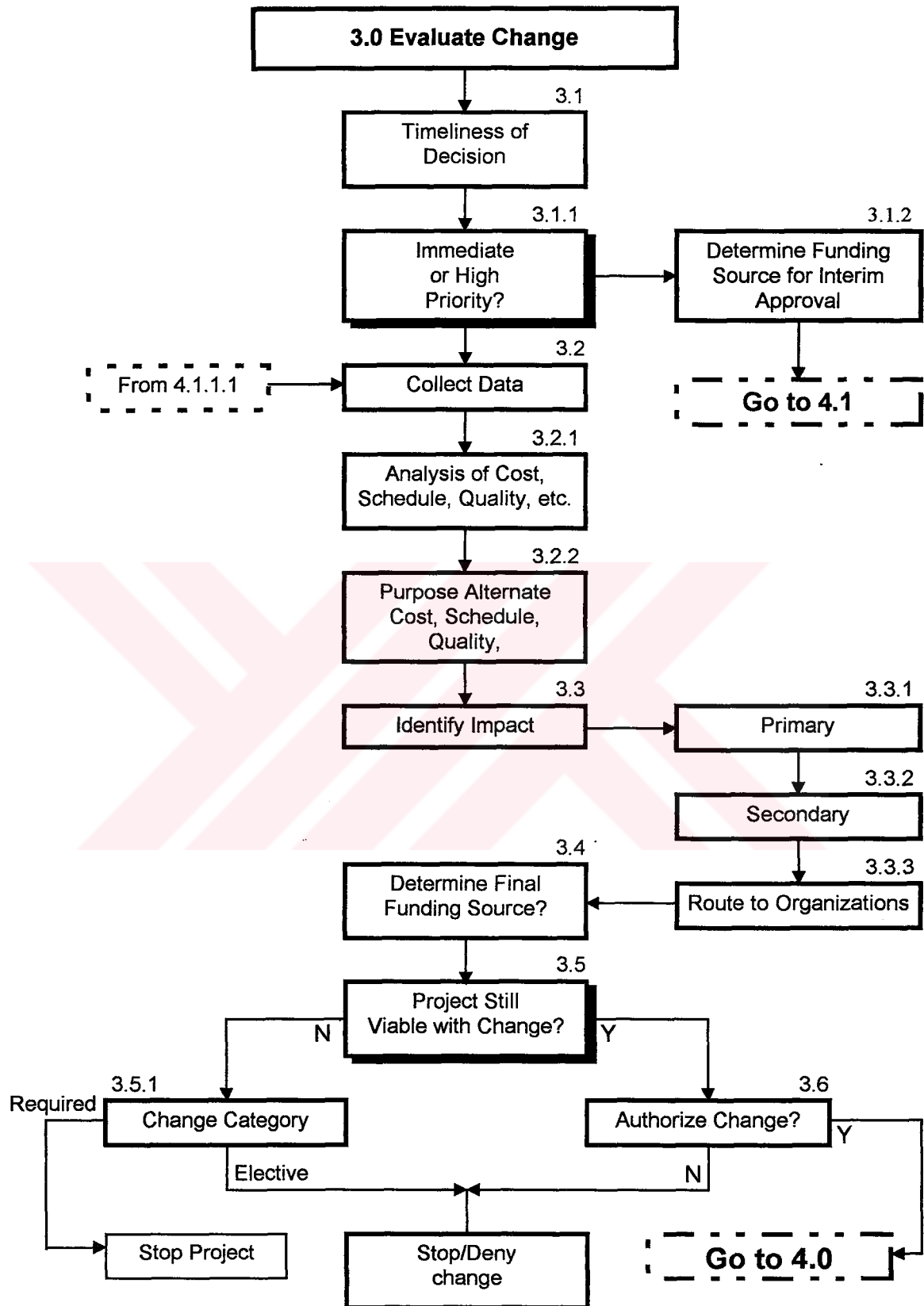
3.3.1.2 Route to all involved disciplines/ functions/ organizations for impact.

3.4 Determine final funding source or "who pays"(cost reimbursable, design development, lump sum, and others). If applicable, confirm the interim funding source decision.

3.5 Re-evaluate project feasibility with proposed change included.

3.5.1 If change makes project unfeasible, determine whether it is a required or an elective change.

3.6 Authorize change and send out notice to all affected organizations/disciplines.



4.0 Implement Change:

4.1 Ensure timely and proper authorization and implementation of change.

4.1.1 Interim authorization- approved, approved with modifications, disapproved.

4.1.1.1 Communicate interim change decision to affected parties. In parallel, proceed with the complete evaluation of the potential change beginning with section 3.2.

4.1.2 Final authorization - approved, approved with modifications, disapproved.

4.2 Communicate final change decision to all affected parties.

4.3 Documented authorization.

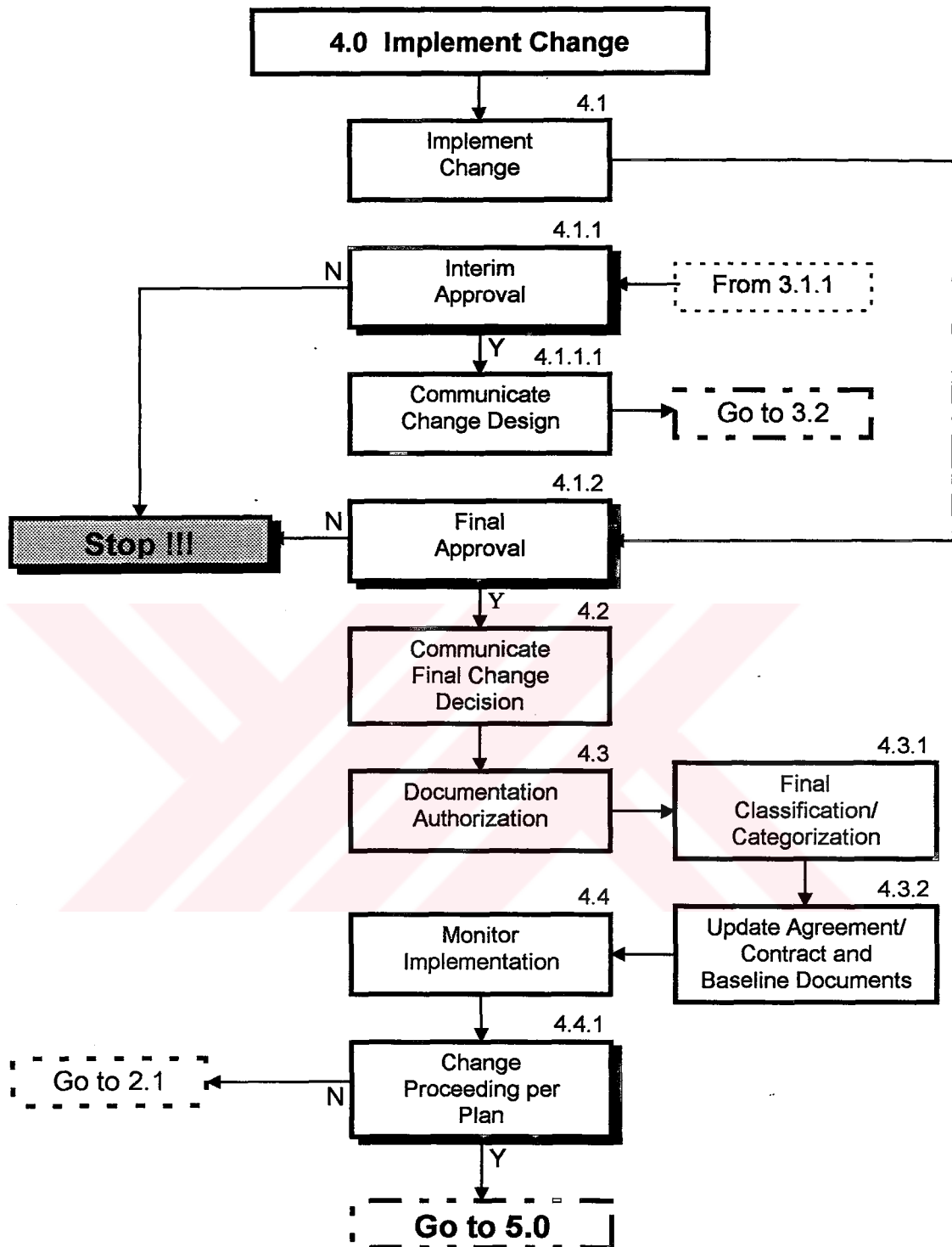
4.3.1 Final classification/ categorization of type of change.

4.3.2 Update project baseline documents for:

- Cost
- Schedule
- Scope
- Contract agreements and documents

4.4 Monitor implementation of change after approval.

4.4.1 Is change implementation proceeding as authorized? If a change deviates significantly from its authorization, handle as a new potential change beginning with section 2.0.



5.0 Continuously Improve from Lessons Learned

5.1 Perform root cause evaluation of change and correct systematic problems.

5.2 Ensure lessons learned are prepared throughout the project life cycle, not just at project completion.

5.2.1 Forward lessons learned and implement corrective actions into current project.

5.3 Update databases (corporate and project) for future project planning.

5.3.1 Cost- primary and secondary

5.3.2 Scope

5.3.3 Schedule

5.3.4 Timing of change.

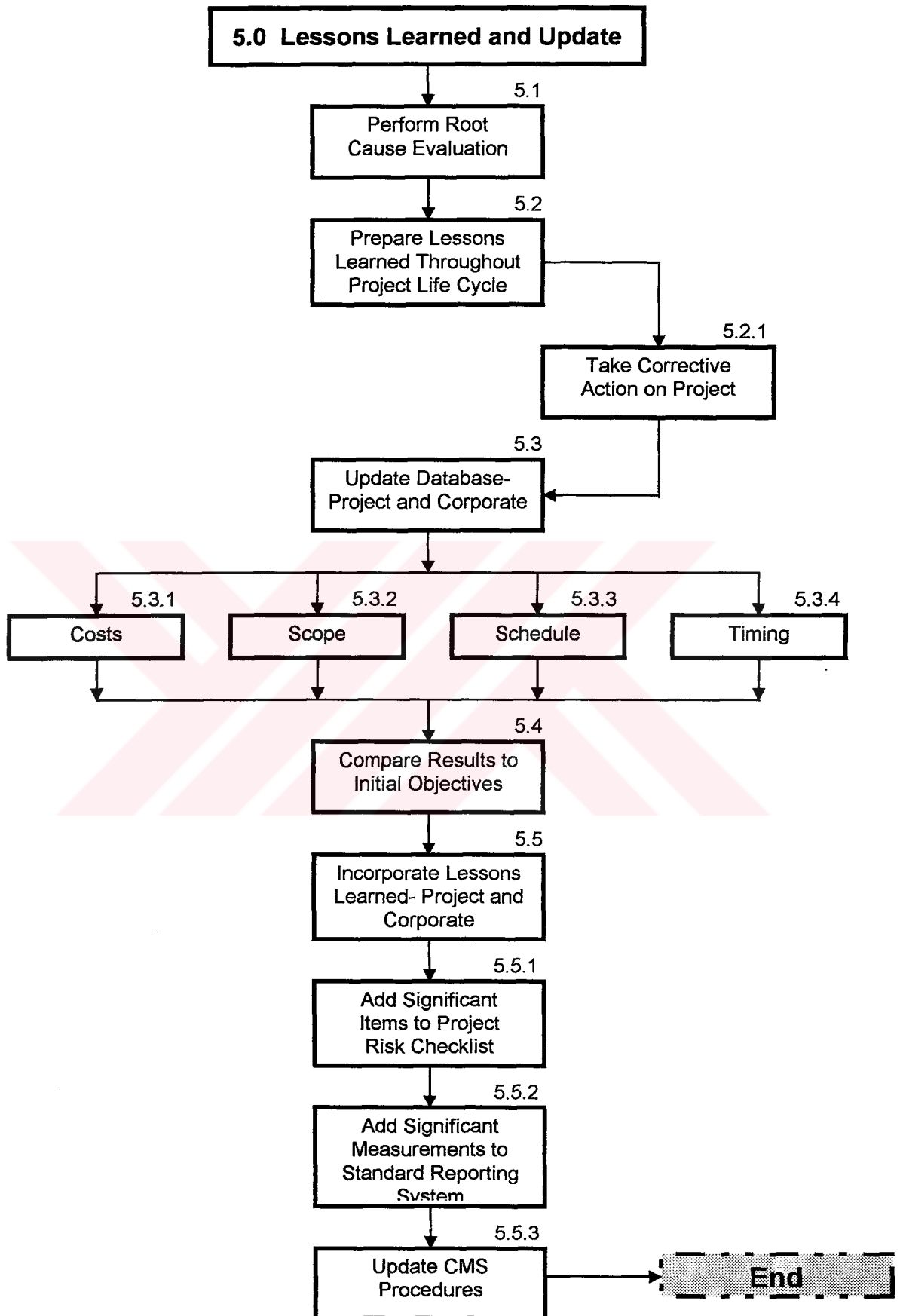
5.4 Compare final project results to initial project business objectives.

5.5 Incorporate lessons learned into standard corporate and project processes, metrics, and so forth.

5.5.1 Add significant items to project risk checklist.

5.5.2 Add significant measurements to standard progress reporting systems.

5.5.3 Update CMS procedures to improve change management.



CONCLUSIONS

This research has studied the causes, types and impacts of projects' changes, and has both identified the dynamics and principles of effective management of changes during the phases of the project life cycle. As the research convincingly shows, the construction industry has not benefited from lessons learned with regard to change management. The following conclusions are offered as ways for the industry to continuously improve:

- The lessons learned from projects are not shared effectively with project teams of future projects nor are they used to improve work processes utilized in subsequent projects.
- Lessons learned are neither identified throughout the project life cycle nor communicated to current and future project participants.
- Changes tend to be viewed as “abnormal occurrences” to be managed as necessary and are expected to be covered by project contingencies. Project could be more successful if the management of change was defined up-front and planned into work execution processes.
- Changes are not evaluated for their root causes. Systemic problems that cause change should be corrected.
- A major root cause for changes is the absences of agreements that are incomplete or otherwise flawed. The lack of clear agreements is also a major cause for disputes relating to change.
- Project changes are the most common source of disruption, disagreements, dissatisfaction and even litigation among participants on projects.
- Changes can be expected to cause declines in engineering and construction productivity.

- If changes cause an increase of scope or slow physical progress, the probability of catching up and completing on-time is reduced, especially late in the project. Project costs are similarly affected.
- Although the construction industry generally acknowledges that the later a change occurs on a project the less efficient it is implemented, a significant number of changes are executed late in the project.
- The engineering and construction industry in general does a poor job of measuring and analyzing the impacts of changes on project costs and other project outcomes.
- In general, project teams do not place sufficient emphasis on the management of change, even though the impact of on project productivity, costs and other project outcomes can be significant.

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Göktuğ Bilgin was born in İstanbul in 1972. He completed his primary education in İstanbul. He graduated from Özel Doğuş Lisesi in 1989 and started his BA in İstanbul Technical University Faculty of Architecture. In 1993 he graduated from this university as an architect and started the Building Project Management Program of İ.T.Ü.- Institute of Science and Technology. 1993 onwards he has been working as a project manager in his father's construction company - Eser İnşaat A.Ş.- located in İstanbul.

