LAUNCHING AN EXTRANET COLLABORATIVE ENVIRONMENT FOR THE CONSTRUCTION INDUSTRY IN THE MIDDLE-EAST

ABSTRACT

An extranet collaborative environment is needed to capture, record, and locate all relevant project information with significant implications for the interactions of the myriad project participants. The electronic environment proposed in this paper collocates all traditional project documents; the construction document drawings, specifications, shop drawings, and submittals, in a single web site for each project. It codifies the relationship between drawings and specifications, and plan files related to each other to improve the coordination of the documents. It enables practicing engineers to know which particular details, equipment choices, specification sections, or project components generate the most owner complaints or contractor change order requests. The paper considers the consequences on the life-cycle-cost, return on investment, and the culture demands in the Middle East region.

ملخـــص:

في ظل الطفرات التكنولوجية الهائلة أصبح من الضروري أن تتوافر البيئة اللازمة لتكوين شبكة معلومات خارجية لتجميع و تسجيل و تنسيق كافة المعلومات الخاصة بمشروع التشييد موضع الاعتبار. و البيئة الإلكترونية المقترحة هنا تقوم بتجميع كافة المستندات و الرسومات و رسومات التنفيذ و المواصفات و الإرساليات المختلفة في موقع خاص بكل مشروع على شبكة الإلكترونية الدولية. و يتم في ذلك الموقع ربط المعلومات المختلفة من رسومات و أنشطة و مواصفات و تغييرات سويا لتطوير الأداء المستندي في المشروع. و يمكن الموقع كافة المهنيين المشاركين في المشروع من معرفة أي تفاصيل مطلوبة و بنود المواصفات أو أي عنصر مما قد يحتاج إلى تغيير أو يكون مصدر خلاف بين أطراف المشروع. و تستعرض الدراسة مردود الموقع على دورة حياة المشروع و النفع الاقتصادي منها و علاقة ذلك بالبيئة الثقافية في الشرق الأوسط و الاحتياجات الخاصة للمنطقة.

INTRODUCTION

The fast developing communication technology provided enormous facilities to boom the traditional national and international commerce utilizing the giant Internet. The application of this new technology in the construction industry in the region has not been effectively utilized yet. The integration of the Internet technology, Internet users, and construction demands need to be real endeavor. The construction industry is fragmented by discipline and geographical location of the stakeholders. This fragmentation motivates the expedition of an electronic collaborative environment. There are many features that need to be included in the environment such as environment scanning process, discussion forums, videoconferencing, and digital archiving. There are few restrictions that control the structure of the required environment. One of these restrictions is the available technologies and experiences in the global market at the time being. The change acceptance is one of the strong barriers in front of the new methodology. Also, the regional culture by its unique nature needs a very special tactic to embark upon the prospective scheme [5, 14 & 16].

The technical and financial measurements and returns due to the utility of the electronic collaboration are depending on the level of planning for the adoption of the new technique [8-16]. This metrics rely on the investor's capacity and objectives, the duration and complexity of the project in which the funds are placed, and the acceptability of the change among all the stakeholders participating in the development and its implementations. Planning for a regional scalable system is an essence in the region to be usable for the various countries in the area according to the local specifications and standards. This plan must consider the expected future needs in the coming five years according to the technological advancements and the technical issues of the construction life cycle [2].

The presented model demonstrates the needs for the local collaborative environment in the Middle East; the features would be included in the product, the main boundaries of the system, and the metrics that shall measure the effectiveness of the collaborative environment.

CONSTRUCTION FRAGMENTATION

In the last two decades, the construction industry acquired a lot of complexity all over the world. Many disciplines are included in the industry; architectural, structural, HVAC, plumbing, mechanical, electrical, etc. Each discipline participating in the construction project views a different aspect of the same physical element and different mechanisms for tracking it. Unfortunately, the relationship between those distinct vantage points is not fitted to the flow of work. Though, it depends on a flow of written correspondences that may reach

all affected parties whether or not the party taking the action is aware of its significance [5 & 14].

The process of designing, constructing, and maintaining a construction is fragmented by phase; schematic design, detailed design, bid, construct, and operation. The construction participants, in many cases, are fragmented geographically. It is common to have a project in the Middle East designed in the United States and assigned to a contractor with home office in South Korea to launch it. Also, the access to different basic construction information is absolutely difficult for all partners, especially during construction process. It is impossible to acquire all required specifications, standards, and even primary design information while working on site.

NEED FOR COLLABORATION

The design and construction of a building is by necessity a collaborative activity, but always remains a question of how to best support collaboration. Communications should not be confused with collaboration [3]. Simply publishing information to a large group of participants doesn't mean the recipients of that information are somehow participating in the process. Also, the tools of communication, faxes, phones, etc., while powerful tools for sharing information, are not necessarily particularly good tools for sharing the creation of work of value. The construction nature always demands the real-time participation of different partners in the construction project [5].

The industry needs a model that organizes the project's information in a collaborative web site on the Internet [6 & 7]. The web site hosts all the information produced, circulated, reviewed, and/or approved with relevance to the project. It, also, controls the flow of information in parallel with the flow of work. The stakeholders can access the web site with specific authorities for each of them to view, upload, modify, approve, and/or forward the data on the project's site. The project's web site is accessible from the owner's office, engineer's office, contractor's office, or all participants on site using a notebook, palm, or mobile (cellular). It is also needed that the system provides essential information on the web site including but not limited to: contract documentation, applicable codes and standards, engineering drawings, shop drawings, specifications, schedules and updates, bills of quantity, request for information, architect's supplementary information, change proposals, cost request bulletins, change orders, photos, discussions (Figure 1), videos, and approvals [13, 14 & 16].

During the design phase, there is a devastating need for a structure of a construction document system; with its related independent plan drawings by the various disciplines that provide a shared space for collaboration. The construction document format of related but individual plans, allows each of the

participating design disciplines, architect, structural, HVAC, electrical, etc. to have a forum for sharing and distributing their finished work. The created shared space allows the contributors to redline, comment, and/or approve the submitted documents and drawings.

The communications during construction need other coordination issues to the project as well. Throughout the construction, the contractor is asking the engineer for specific and detailed information about the design. These Request For Information's (RFIs) generate Architects Supplemental Information (ASIs), Change Proposals, requests by the owner or engineer for cost estimates (Cost Request Bulletins), and Change Orders [6]. The relationships between these information requests and responses, the construction documents, and the project schedule are numerous. Understanding those relationships has led to individual commercial software products that almost do nothing but track the paperwork. The quality of the documents is of course a different matter. If the facility truly meets the needs of the owner, there is an enormous impact on the value of the project, but that is heavily dependent on how effective were the communications between the owner and engineer. If the construction change orders were cut in half, that could be an enormous difference in quality and cost as well, but again that is a function of how successful the communications were between engineer and contractor [14].

It is much more likely that the project model will take the form of a single model in the same way that a collection of externally referenced CAD files form a single "drawing", or an array of data tables on separate computers forms a relational data base. The model that will describe a building project will be a single model in that all the individual data sets are referring to a single coherent understanding of the intended built project. The data sets, however, will inevitably reside on workstations and file servers that are physically and organizationally remote from each other.

FEATURES OF THE COLLABORATIVE ENVIRONMENT

The proposed model develops the required shared space to capture, circulate, and control the required information of the construction project. The common space and the workflow control allow all stakeholders to share the ideas and improve decision-making processes through all construction phases [5, 8, 10, 13 & 16].

The electronic environment collocates all traditional project documents (Figure 2); the construction document drawings, specifications, shop drawings, and submittals, in a single web site for each project. It codifies the relationship between drawings and specifications, and plan files related to each other to improve the coordination of the documents. It enables practicing engineers to know which particular details, equipment choices, specification sections, or

project components generate the most owner complaints or contractor change order requests. The required scheme provides the construction partners with most of the essential basic information that help to accelerate and improve the productivity of the construction processes. Available information will minimize disputes and eliminate subsequent time and cost consuming.

Project database users are granted access only to specific projects. Each project can be assigned a list of companies and employees who are active on the project. Detailed project information is tracked, such as architectural contacts, bid amounts, etc. All of the major items such as RFI's, Documents, etc. in the product are sorted by project, making it easy to reference the information of the project you are working on. User account database handles both employees and non-employees, allows setting up login accounts tailored to individual users. For example, an architect can be given rights to only respond to RFIs, a corporate accountant can be granted access to the budgeting module, or a contractor allowed to view drawings and submit change requests.

Bid solicitation is available within the targeted environment including: call sheets producing professional and easy to complete sheets in seconds. For larger projects, creates split call sheets by CSI Code, which distributes calls to multiple staff members. Custom templates create and upload multiple bid invitations for various projects and requirements. Templates are automatically filled in by the system using information from the database. The required scheme allows for business development competition by recording and tracking competitive bids for later analysis. The contract history views a log of changes to a project contract. Project setup and information store the basics of each project, including address, phone numbers, and key contacts.

EXPECTED IMPACTS

The biggest risk to be faced in a project is not having the proper systems in place to ensure that delivery of the project is on time and under budget. The compensation and project profitability depend upon it. The proposed solution provides a single point of access and control to reduce risk and ensure accountability among all key dependencies. The utilized business process guides team members through everyday, essential activities such as contracts, memos, requests for information (RFIs), submittals, change orders, schedules, plans and drawings, which can then be accessed anytime, anywhere by authorized users over the Internet. It facilitates proactive action by team members to reduce the risk of unforeseen problems causing schedule delays or cost overruns [13 & 16].

There is more need to wait for, or travel to, the next scheduled meeting with all team members to detect and correct issues. Time and travel costs associated with physically bringing together all the team members in one room, as well as printing and courier charges, are significantly reduced, if not eliminated. It is

even possible to manage projects and people in the palm of the hand using the solution with a lightweight palm organizer. It is easy to fast track the projects by accelerating cycle times on document reviews such as RFIs, submittals, change orders, schedule, plans and drawings. The solution encapsulates the construction industry's best practices with the presented model. This model's templates are used to model the firm's competitive best practices that are then followed by all project team members. The model eliminates confusion and shortens the time it takes to resolve issues. From the simplest announcement to the most complex RFI, information moves quickly to the right people and every step is tracked and recorded in an audit trail.

The presented solution gives complete oversight and control over all project team members, roles, action items, and responsibilities. It is easy to tailor viewing and editing privileges to each individual and company's role. Mistakes, bottlenecks, or missed deadlines can be identified early on, enabling all participants to take swift and correct action before they spiral out of control. The solution also facilitates record keeping with its audit trail, tracks safety compliance meetings and provides the ability to file project notes and other project correspondence. Using the presented solution, it facilitates making proactive, educated decisions on issues that arise during the course of the project instead of reacting to problems and correcting mistakes after the fact. Stakeholders will be able to implement immediate, accurate, and predictable results [3 & 11-14].

PROJECT LIFE CYCLE MANAGEMENT

The ability to perform life cycle cost analyses that will be useful for management decision-making is largely dependent on the ability to predict the amount and timing of future resource consumption. The time dimension is often important in cost calculations; the time when resources are bought and the rate at which they are consumed can have a significant cost influence on the project. Time or the schedule of a project's work can, if it is not properly managed, have a dramatic influence on cost; schedule overruns can be very expensive even though the amount of useful work done changes very little. The impact of time on cost is dramatic in the phase of operation and maintenance of the construction since the uncertainties are much higher than design and construction phases. Figure (3) presents the main common phases of the construction life cycle.

When planning and analyzing a prospective project and its development, it is usual to assume that the development will be sufficient to meet the required service life. In practice equipment and plant often change during service operation. The changes are usually required to meet new system requirements or to take advantage of new methods of working or of new technology. Although

this will probably happen, it is not known when or how. For these reasons it is usual to omit from the life cycle cost analysis (LCCA) in-service development and system change or enhancement during its life. LCCA is based on the system as it is now envisaged while future possible but unspecified changes are ignored. Such changes in the future should be dealt with as a new development decision at that time using LCCA of the change as part of that decision process. Having well-archived files for the construction is what the LCCA needs to prepare proactive plans to mitigate potential risk events [2].

The cost of any project depends primarily on the costs of operation and maintenance in addition to the initial cost of the project's structure. It is mandatory to have a comprehensive scanning for every minor item in the operated project to enhance the capacity to control the costs of this phase. The proposed environment provides the required devices for this targeted control. By making use of the available communication facilities through the proposed extranet environment, construction firms can take responsibility for the monitoring and maintenance of the facilities through its entire life cycle, in addition to the design and construction of the facility. The collaborative environment provides the advantage to approach maintenance in a proactive and preventive manner rather than in a reactive mode.

Since there are partners in the ownership, management, operation and maintenance of the specified facility, what is required is a collaborative and shared information infrastructure that allows the appropriate party to be notified of any action that needs to be taken, while at the same time ensuring that others who may be impacted by these corrective/ maintenance actions are also notified. The scope and content of an LCCA are wholly determined by the needs of the project and its project manager.

Data gathering is bedeviled by the inadequacy of historic project records for the purpose for which they are now required. Apart from the technical differences of the new project, there are often problems of perception and definition. A cost can be a quite different thing to an investor, to a project engineer; to a maintenance manager; to an accountant or to a sub-contractor and data definitions must match or be made to match. It is also necessary to know whether reported costs are current or to which base year they refer, and what overheads are allocated and whether profit is included or not. There is rarely such a thing as a simple straightforward "cost" already available. It should also be recognized that some of the analyses are bound to be subjective and past data often missing or inadequately defined. Once data collection is complete, the calculation of LCCA profiles is usually a relatively quick task particularly when computerized models and tools are used.

TECHNOLOGY- CULTURE- PROCESS

Besides all the technological facilities presented in the last decade, it is required to acknowledge that most of the construction processes are conducted in the conventional manner with slight contribution from the technological surge. For example, the design drawings and its details still in the 2D phase despite the spread of 3D-CAD software in most of the construction firms [1 & 4]. On the other hand, a very small number of construction firms started to utilize the Internet as an environment for communication through the different phases of the construction project. If we admit that there is only about 20% of the firms in the U.S. are making use of the electronic features as e-mail, internal networks, intranets, or extranets, there would be a fraction of one percent of the Middle Eastern companies using these facilities effectively.

The cultural effect on utilizing the technological advancements is a prime parameter in the delay of implementing these features. Change rejection is one of the major cultural barriers that oppose the application of the communication tools available for the construction industry. This rejection is common in all cultures with variable impacts from one to another. In the developing countries, the partners used to follow the development of new methodology from the very beginning and chase the studies and experimental application of them. The mutual interaction between the partners and the development firms provide the required field to accept the projected change.

In the developing countries, it is difficult to adopt the imported methodologies before paving the market through many directions. Marketing taskforce is always needed to brainstorm the managers of top companies in the region in order to convince them with the distributed product. Sometimes, the participation of foreign companies in the local construction processes helps to accelerate the acceptance of the change. Also, the participation of giant construction participant like the governments pushes the cycle of change. Even with these tools, remains the need to enforce the change at lower levels of firms to adopt the new features. This enforcement demands a lot of contribution from the construction key holders in the region whether governmental and from the private sector.

Despite that the change acceptance concept is concerned with the stakeholders of the construction industry, the contribution of other agencies is always essential to allow for better communication connectivity and access to the tools and techniques to be implemented. Communication departments and companies in charge have a big role to play in spreading the knowledge and the tools to make the Internet access more popular and faster so as to acquire the needs of the construction communication on the level of human acceptability and information capturing and distribution requirements.

In the era of the new world order, it is evident that the most dominating language is the English. However, the bilingual Arabic/English culture is the actual conduct in the Middle East region. The English is an essence to the participating foreign companies who constitute a major session in the infrastructure projects and large construction projects and for the foreigners who constitute a large sector in the local companies especially in those in the Gulf region. On the other hand, it is essence to have a parallel Arabic alternative to have the subcontractors participate in the system. Most of the subcontractors have difficulties to contribute to the system in English. The temporary solution for this point is to assign administration staff that has the capacity to communicate with the subcontractors and the English version that is available at the time being from the outside market.

Another parameter that must be considered in the cultural effect on the required collaborative environment is the local standards and specifications. It has been a tradition in the region, especially in large projects, to utilize a combination between local specifications and foreign specifications basically U.S. and British specifications according to the nationality of the contributing contractors and engineers. It is essential to develop unified regional specifications and standards that govern the construction processes including design, construction, materials, maintenance, and all management processes. The developed standards will be applicable to the mass production of the products and the communication tools as well. Hence, whether these tools are locally produced or imported from outside the region, all items incorporated in the system will be in accord with the developed standards. Figure (4) introduces the interrelationship among the three endeavors; technology, culture, and process.

RETURN ON INVESTMENT

The investments in the filed of collaboration and information technology at all with respect to construction industry can be categorized into few main sectors (Figure 5). These sectors are software, hardware, training, support, and personnel. The amount of investment depends on other few factors such as the investor's capacity and objectives, the duration and complexity of the project in which the funds are placed, and the acceptability of the change among all the stakeholders participating in the development and its implementations. The distribution of expenses on the main categories depends on the continuity of the investments with the personnel at the top of the list in this regard. Costs incurred in training and educating personnel for the adopted technology varies a lot with the conditions and terms of employing the staff members. Staffs who are continuing in other projects with the same investor reduce the over all costs spent on training and staff preparation. If the employees would spill over after finishing the concerned project the cost of developing the collaborative environment would be much higher and the return much less [13 & 16].

The categories and measurements of returns can be chased in the areas of value added in the concerned project or program. These areas mainly are productivity improvement, quality enhancement, risk mitigation, and time attenuation. These returns can be measured throughout the project as long as the collaboration environment is effectively activated. The measurement of the return is quantified by the standard production for each product and each phase and comparing the actual output by these standards. Beside these measurable amounts, there are usually negative returns. For example, the trained employee is a big return for the project's investments. The information technology experiences in general counts for high ranked return because of the lack of these experiences, especially in the Middle East region. These internal experiences reduce the costs may be incurred for acquire the same level of well-trained staff. Another example for negative return is the created environment with the spirit of change acceptance in the enterprise. Once this spirit is born it is easy to maintain in the system as long as the majority of the staff are not spilled over in the meantime.

FUTURE NEEDS

The current needs are always tied up to the future needs. The expected development of technology adoption in the construction field in the Middle East region is governed by the motives and the possibilities for change in the coming five years. The available fragmented technologies related to the construction industry can be integrated to provide more advanced methodology in controlling the life cycle of the construction. For example, the technology of sensors can be utilized in parallel with the e-management environment offered already by many applicators. This integration will allow for the life long follow up and control over the construction in a proactive manner. These sensors may be applied for the structural elements like columns and walls, environmental elements like temperature and pollution, or utility like applied loads and inhabitation. These records facilitate the operation and maintenance for better decision making based on well-established database for all controlling parameters. Hence, the value added here will be in the form of operation cost reduction, advanced utility, and longer life span for the facility.

Another feature that will be essential to pop out to the construction industry is the integral of all main managerial parameters. Besides the expected application of the 3D system mentioned-above, the integration of A/E/C design, construction, and operation along with time and cost in a unified structure will support the required comprehensive collaborative environment. The adoption of time and cost in the system enhances the conventional 2D system up to extra-enhanced 5D system. The integrated system will facilitate a higher level of managerial control over the construction. The integration of cost, time, and

quality in a unique electronic-control environment will lead to a perfect synchronized structure among facility users, supervisors, and owners

Again, the fully integrated system will need a higher capacitive standardized system that can be manipulated among all construction firms in the region of the Middle East. This system needs to be developed as early as possible to capture the current technologies and needs and fit them in the structure from the very beginning. Running the system earlier provide the space to test it and adjust it according to the local experiences and specification. Then, the updated technologies and needs will be easier to be adopted in the system.

The developed collaborative environment will add many features that enhance the productivity of the team, improve teamwork capacity, minimize project expenses, mitigate risk potentials and impacts on the project, etc. Figure (6) illustrates the projected value added due to the various collaboration functions. Some of these functions include minor collaborative nature in their disposition but they are needed for the structure of the environment to enhance the value of the facility such as security, digital archiving, and final project status. Other functions have major collaborative built in nature and mean time have a high impact on the value of the facility like life cycle control, change management, and accountability of all participating stakeholders.

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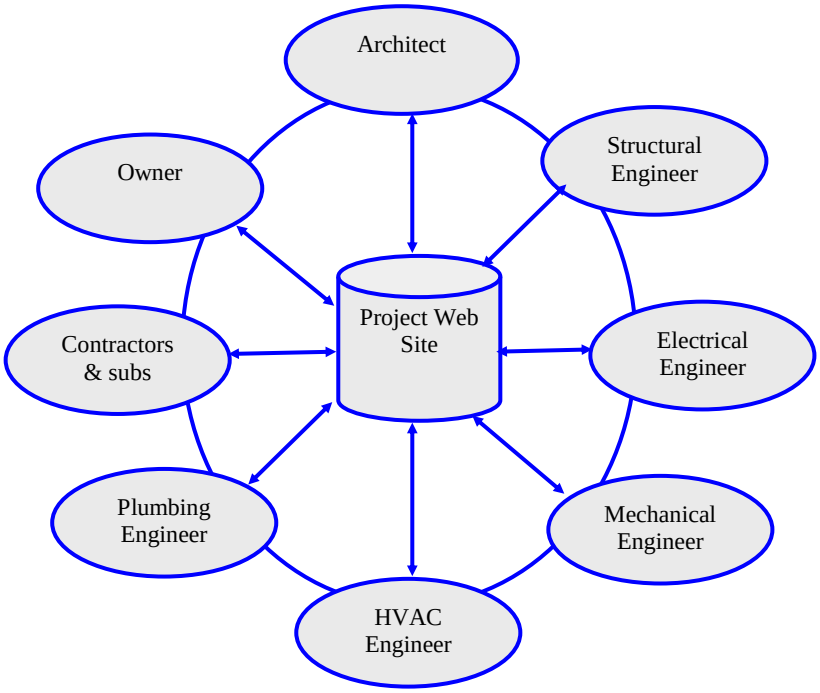

Figure (1) Discussion forum in various phases

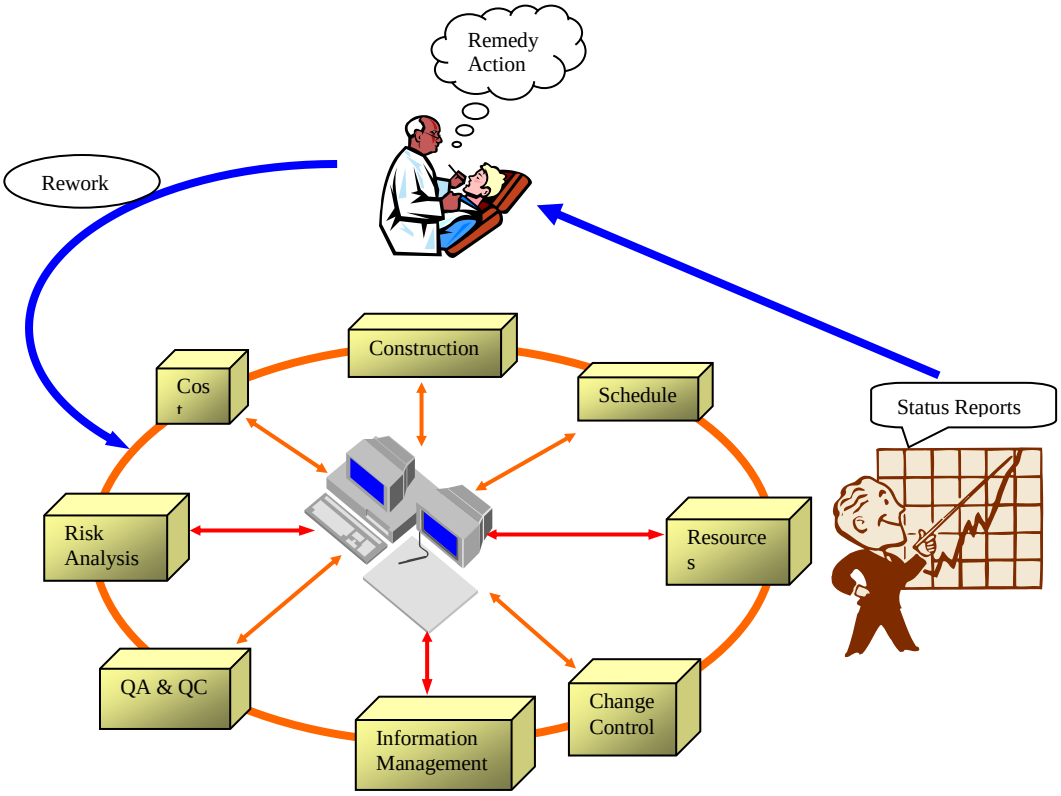

Figure (2): Collaboration of various processes in the project

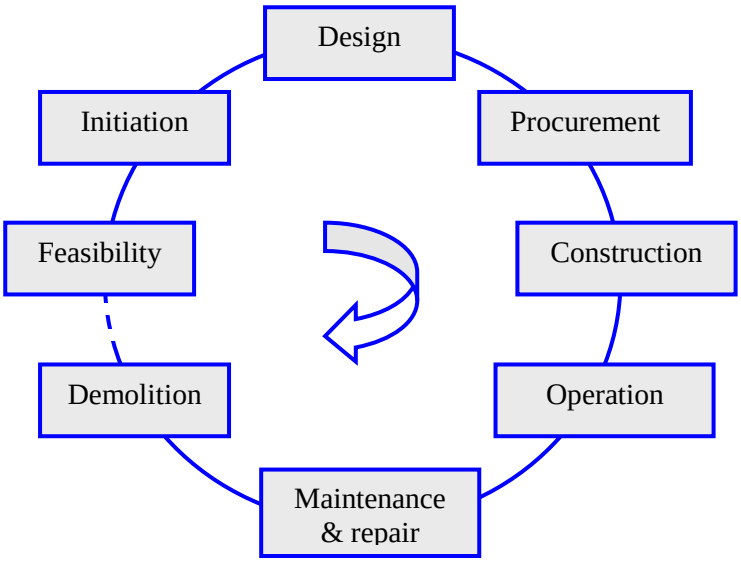

Figure (3): Construction project life cycle

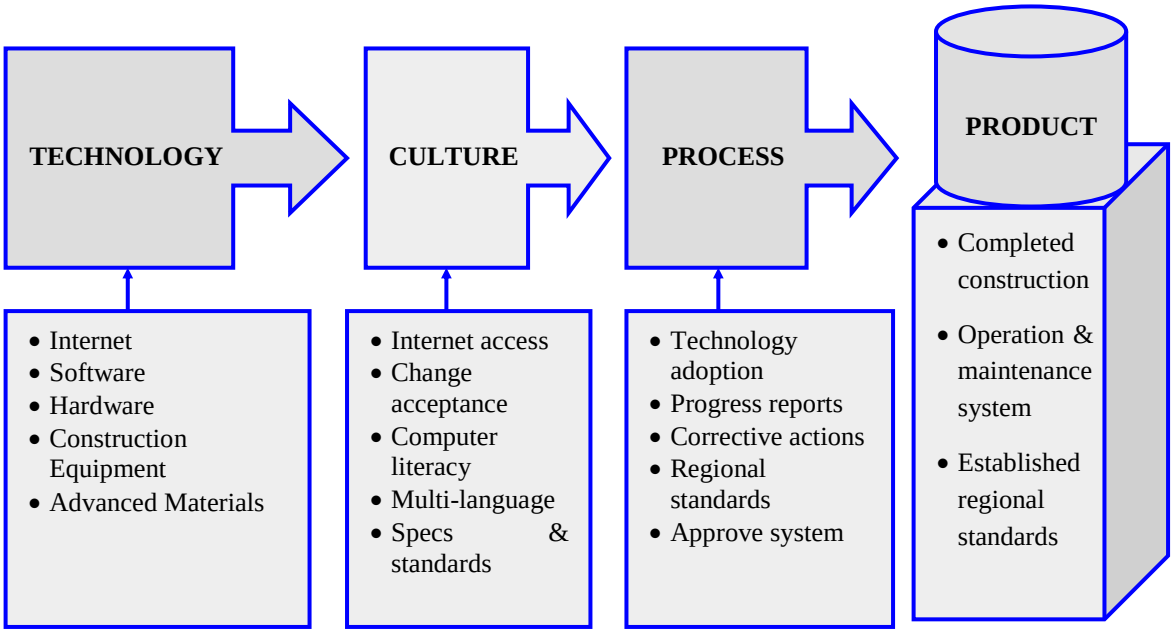

Figure (4): Technology – Culture – Process Relationship

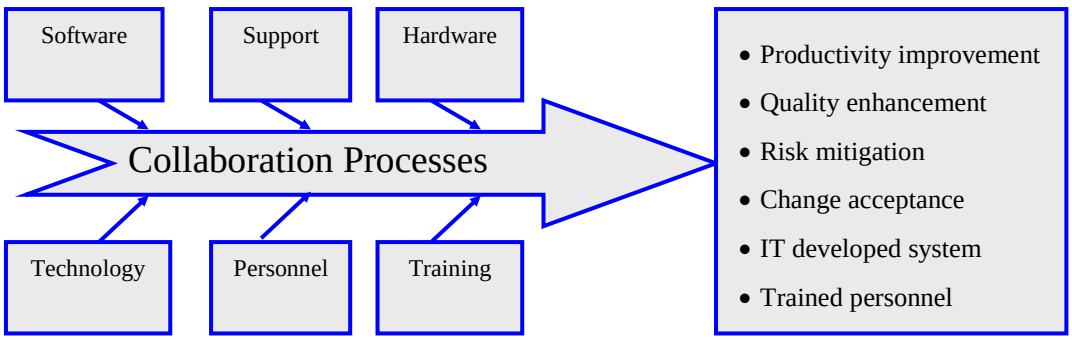

Figure (5): Fishbone of expenses and returns relationship

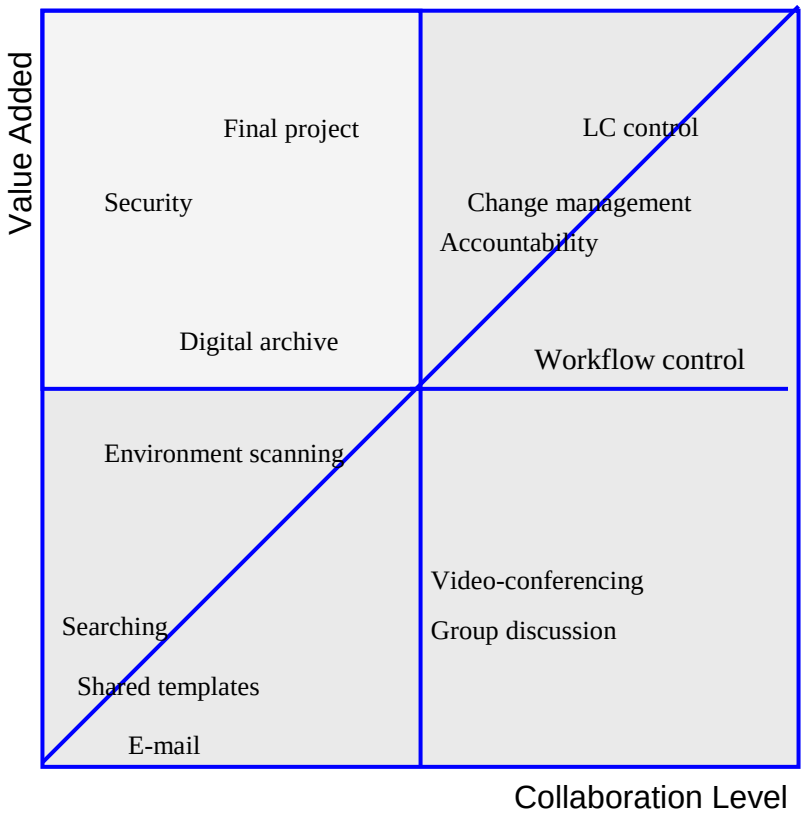

Figure (6): Collaboration level vs. value added relationship