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Reynolds **January 16, 2018**

System and method for industrial project cost estimation risk analysis

Abstract

A computer apparatus and method for analyzing and improving industrial turnaround or construction project manpower estimates. The apparatus comprises one or more processors in operative communication with one or more data stores and with at least one tangible medium upon which is encoded machine-readable software, the software, upon its execution, being configured so that the system carries out a process for analyzing and adjusting manpower cost estimates, outputting actionable results for display to users, and archiving and aggregating project execution data for use in future project analyzes to improve analysis and estimation accuracy over time by feeding back into the system data indicative of the scale and sources of historical execution inefficiencies.

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Parent Case Text

REFERENCE TO RELATED APPLICATIONS

Claim is hereby made to the benefit of the priority of U.S. Provisional Patent Appl. No. 61/881,301, filed on Sep. 23, 2013, the disclosure of which is incorporated herein by reference.

Claims

The invention claimed is:

1. Computer apparatus for analyzing industrial turnaround or construction project execution estimates, the

apparatus comprising one or more data stores, one or more processors in operative communication with the data stores, and one or more tangible computer-readable media upon which is encoded machine-readable software which, upon its execution, is configured so that the system carries out a process comprising: receiving from one or more user interfaces, and storing in one or more of the data stores, current estimated data expressed initially as, or convertible into, and one or more of current estimated cost data, current estimated man-hour data and current estimated duration data, attributable a plurality of risk-determinative conditions for one or more project tasks; receiving from one or more of the user interfaces, and storing in one or more of the data stores, historical estimated potential inefficiency contributor data expressed initially as, or convertible into, one or more of historical estimated cost data, historical estimated man-hour data and historical estimated duration data, attributable to each of the risk-determinative conditions for the project tasks; receiving from one or more of the user interfaces, and storing in one or more of the data stores, one or more quantitative adjustments to the current estimated data and the historical estimated potential inefficiency contributor data, which quantitative adjustments at least in part account for either anomalous historical risk which is no longer anticipated with respect to the historical estimated potential inefficiency contributor data, or newly known risk which is anticipated with respect to the current estimated data, or both, and by means of the processors summing the quantitative adjustments, if any, respectively with the current estimated data and the historical estimated potential inefficiency contributor data attributable to each of the risk-determinative conditions for the project tasks, to yield validated current estimated data and validated historical estimated potential inefficiency contributor data attributable to each of the risk-determinative conditions for the project tasks; calculating by means of one or more of the processors a difference between a current estimated inefficiency factor applied to the validated current estimated data and a projected inefficiency factor applied to the validated historical estimated potential inefficiency contributor data for each of the risk-determinative conditions for each of the project tasks, to yield an initial risk value for each of the risk-determinative conditions for each of the project tasks; receiving from one or more of the user interfaces, and storing in one or more of the data stores, a probability of occurrence for each of the risk-determinative conditions and calculating a quantified value of risk for each of the risk-determinative conditions by multiplying each of the initial risk values by the respective probability of occurrence; receiving from one or more of the user interfaces, and storing in one or more of the data stores, a probability of mitigation success for each of the risk-determinative conditions and any cost of mitigation to be undertaken; calculating by means of one or more of the processors a final risk value for each of the risk-determinative conditions, by multiplying each probability of mitigation success by the respective quantified value of risk for each of the risk-determinative conditions, and summing the resulting product with the cost of mitigation to be undertaken; and generating by means of one or more of the processors a final risk value output configured to enable a representation of the final risk value for each of the risk-determinative conditions to be electronically displayed.

2. The computer system of claim 1, wherein the software is further configured so that the system carries out a process further comprising: calculating by means of one or more of the processors adjusted estimated costs, adjusted estimated man-hours and adjusted estimated duration for each of the project tasks, by summing the current estimated costs, current estimated duration and current estimated man-hours for each of the project tasks, with the sum of all of the final risk values for the risk-determinative conditions for each of the project tasks respectively; and generating by means of one or more of the processors an adjusted estimates output configured to enable a representation of the adjusted estimated costs, adjusted estimated man-hours and adjusted estimated duration for each of the project tasks respectively, for the project as a whole, or for both, to be electronically displayed.

3. The computer apparatus of claim 2, further comprising a display configured to receive the final risk value output, the adjusted estimates output, or both, and to display their respective representation(s).

4. The computer apparatus according to any of claims 1-3, wherein the quantitative adjustments to the current estimated data and the historical estimated potential inefficiency contributor data, are prepared by conducting one or more collaborative interviews with a first plurality of personnel experienced in comparable project execution, and wherein the probability of occurrence for each of the risk-determinative conditions and the probability of mitigation success for each for each of the risk-determinative conditions are each determined by collaborative consensus amongst a second plurality of personnel experienced in comparable project execution.

5. The computer apparatus according to claim 4, wherein the process carried out by the system further comprises: receiving from one or more of the user interfaces, and storing in one or more of the data stores,

realized potential inefficiency contributor data expressed initially as, or convertible into, one or more of realized cost data, realized man-hour data and realized duration data, attributable to each of the plurality of risk-determinative conditions for the one or more project tasks; calculating, by means of one or more of the processors, the difference between the validated current estimated potential inefficiency contributor data and the realized potential inefficiency contributor data for each of the risk-determinative conditions for each of the project tasks, to yield a realized actual inefficiency value for each of the risk-determinative conditions for each of the project tasks; and calculating, by means of one or more of the processors, a realized risk for each of the risk-determinative conditions for each of the project tasks by subtracting the realized actual inefficiency value from the final risk previously calculated respectively for each of the risk-determinative conditions for each of the project tasks.

6. The computer apparatus according to claim 5, wherein the process carried out by the system further comprises: employing the stored, realized potential inefficiency contributor data of the project tasks as historical estimated potential inefficiency contributor data and repeating the foregoing steps with respect to current estimated data specific to another set of one or more project tasks of a different project, so as to calculate, by means of one or more of the processors, initial risk values for the one or more risk-determinative conditions of the one or more project tasks of the different project.

7. The computer apparatus according to any of claims 1-3, wherein the process carried out by the system further comprises: receiving from one or more of the user interfaces, and storing in one or more of the data stores, realized potential inefficiency contributor data expressed initially as, or convertible into, one or more of realized cost data, realized man-hour data and realized duration data, attributable to each of the plurality of risk-determinative conditions for the one or more project tasks; calculating, by means of one or more of the processors, the difference between the validated historical estimated potential inefficiency contributor data and the realized potential inefficiency contributor data for each of the risk-determinative conditions for each of the project tasks, to yield a realized actual inefficiency value for each of the risk-determinative conditions for each of the project tasks; and calculating, by means of one or more of the processors, a realized risk for each of the risk-determinative conditions for each of the project tasks by subtracting the realized actual inefficiency value from the final risk previously calculated respectively for each of the risk-determinative conditions for each of the project tasks.

8. The computer apparatus according to claim 7, wherein the process carried out by the system further comprises: employing the stored, realized potential inefficiency contributor data of the project tasks as historical estimated potential inefficiency contributor data and repeating the foregoing steps with respect to current estimated data specific to another set of one or more project tasks of a different project, so as to calculate, by means of one or more of the processors, initial risk values for the one or more risk-determinative conditions of the one or more project tasks of the different project.

9. A computerized method of preparing an industrial turnaround or construction project execution estimate analysis, the method comprising: receiving from one or more computer interfaces, and storing in one or more data stores, current estimated data expressed initially as, or convertible into, one or more of current estimated cost data, current estimated man-hour data and current estimated duration data, attributable to a plurality of risk-determinative conditions for one or more project tasks; receiving from one or more of the computer interfaces, and storing in one or more of the data stores, historical estimated potential inefficiency contributor data expressed initially as, or convertible into, one or more of historical estimated cost data, historical estimated man-hour data and historical estimated duration data, attributable to the risk-determinative conditions for the project tasks; conducting one or more collaborative interviews with a first plurality of personnel experienced in comparable project execution, so as to develop one or more quantitative adjustments to the current estimated data and the historical estimated potential inefficiency contributor data, which quantitative adjustments at least in part account for either anomalous historical risk which is no longer anticipated with respect to the historical estimated potential inefficiency contributor data, or new known risk which is anticipated with respect to the current estimated data, or both; receiving from one or more of the computer interfaces, and storing in the data stores, the one or more quantitative adjustments to the current estimated data and the historical estimated potential inefficiency contributor data attributable to the risk-determinative conditions for the project tasks, and summing, by means of one or more processors in operative communication with the data stores, the quantitative adjustments, if any, respectively with the current estimated data and the historical estimated potential inefficiency contributor data attributable to each of the risk-determinative conditions for the project tasks, to yield validated current estimated data and

validated historical estimated potential inefficiency contributor data attributable to each of the risk-determinative conditions for each of the project tasks; calculating by means of one or more of the processors a difference between a current estimated inefficiency factor applied to the validated current estimated data and a projected inefficiency factor applied to the validated historical estimated potential inefficiency contributor data for each of the risk-determinative conditions for each of the project tasks, to yield an initial risk value for each of the risk-determinative conditions for each of the project tasks; conducting one or more collaborations with a second plurality of personnel experienced in comparable project execution, in order to establish by consensus a probability of occurrence for each of the risk-determinative conditions and a probability of mitigation success for each of the risk-determinative conditions; receiving from one or more of the computer interfaces, and storing in one or more of the data stores, the probability of occurrence for each of the risk-determinative conditions and calculating, by means of one or more of the processors, a quantified value of risk for each of the risk-determinative conditions by multiplying each of the initial risk values by the respective probability of occurrence; receiving from one or more of the computer interfaces, and storing in one or more of the data stores, the probability of mitigation success for each of the risk-determinative conditions; computing, by means of one or more of the processors, a final risk value for each of the risk-determinative conditions, by multiplying each probability of mitigation success by the respective quantified value of risk for each of the risk-determinative conditions, and summing the resulting product with any cost of mitigation to be undertaken; and generating, by means of one or more of the processors, a final risk value output configured to enable a representation of the final risk value for each of the risk-determinative conditions to be electronically displayed.

10. The computerized method of claim 9, further comprising: calculating by means of one or more of the processors, adjusted estimated costs, adjusted estimated man-hours and adjusted estimated duration for each of the project tasks, by summing the current estimated costs, current estimated duration and current estimated man-hours for each project task with the final risk values calculated for all of the plurality of risk-determinative conditions for the respective project task, and generating for display on an electronic display an output of the adjusted estimated costs, adjusted estimated man-hours and adjusted duration for each of the project tasks, for the project as a whole, or for both.

11. The computerized method of claim 10, further comprising displaying on the electronic display the output of the adjusted estimated costs, man-hours and duration for each of the project tasks.

12. The computerized method of claim 9, further comprising: receiving from one or more of the user interfaces, and storing in one or more of the data stores, realized potential inefficiency contributor data expressed initially as, or convertible into, one or more of realized cost data, realized man-hour data and realized duration data, attributable to each of the plurality of risk-determinative conditions for the one or more project tasks; calculating, by means of one or more of the processors, the difference between the validated historical estimated potential inefficiency contributor data and the realized potential inefficiency contributor data for each of the risk-determinative conditions for each of the project tasks, to yield a realized actual inefficiency value for each of the risk-determinative conditions for each of the project tasks; and calculating, by means of the processors, a realized risk for each of the risk-determinative conditions for each of the project tasks by subtracting the realized actual inefficiency value from the final risk previously calculated respectively for each of the risk-determinative conditions for each of the project tasks.

13. The computerized method of claim 12, further comprising employing the stored, realized potential inefficiency contributor data of the project tasks as historical estimated potential inefficiency contributor data and repeating the foregoing steps with respect to current estimated data specific to another set of one or more project tasks of a different project, so as to calculate, by means of one or more of the processors, initial risk values for the one or more risk-determinative conditions of the one or more project tasks of the different project.

Description

TECHNICAL FIELD

The subject of this disclosure is in the technical field of computerized systems and methods for analyzing risk associated with manpower costs and schedules for industrial turnaround maintenance and construction project execution.

SUMMARY OF THE INVENTION

Accurate cost estimates for manpower involved in industrial construction or industrial maintenance project execution, including for example turnaround projects in the chemical, oil & gas, paper and agricultural processing industries, are critical to both vendors and buyers of industrial construction and maintenance services. In large projects involving complex systems, preparing such estimates accurately can be a highly complex endeavor, in part because of the volume of variable cost-driving conditions involved and the number and diversity of contingent risks involving manpower productivity which may or may not be realized during execution of a given project. Historically, the assessment of the accuracy of project estimates in this industrial space, especially as it relates to manpower productivity, has been an exercise in reliance upon trial and error, and upon the ability of documented records and human personnel to accurately reconstruct historical risk factor experience from previous related projects.

For at least these reasons, a significant need continues to exist for a more efficient, systematic approach to analysis of manpower cost and time schedule estimates for such projects, which more accurately evaluates and measures project risk and risk mitigation potential, in order to ultimately produce project manpower cost and/or schedule estimates with greater accuracy, resulting in greater cost savings and ultimately greater profitability.

The invention which is the subject of this disclosure addresses this and other needs by providing, in at least one aspect, a computer apparatus or system for analyzing industrial turnaround project execution estimates, or construction project execution estimates, or turnaround and construction project execution estimates. In this aspect of the invention, the apparatus comprises one or more data stores, one or more processors in operative communication with the data stores, and one or more tangible computer-readable media upon which is encoded machine-readable software which, upon its execution, is configured so that the system carries out a process comprising: receiving from one or more user interfaces, and storing in one or more of the data stores, current estimated data expressed initially as, or convertible into, and one or more of current estimated cost data, current estimated man-hour data and current estimated duration data, attributable a plurality of risk-determinative conditions for one or more project tasks; receiving from one or more of the user interfaces, and storing in one or more of the data stores, historical estimated potential inefficiency contributor data expressed initially as, or convertible into, one or more of historical estimated cost data, historical estimated man-hour data and historical estimated duration data, attributable to each of the risk-determinative conditions for the project tasks; receiving from one or more of the user interfaces, and storing in one or more of the data stores, one or more quantitative adjustments to the current estimated data and the historical estimated potential inefficiency contributor data, which quantitative adjustments at least in part account for either anomalous historical risk which is no longer anticipated with respect to the historical estimated potential inefficiency contributor data, or newly known risk which is anticipated with respect to the current estimated data, or both, and by means of the processors summing the quantitative adjustments, if any, respectively with the current estimated data and the historical estimated potential inefficiency contributor data attributable to each of the risk-determinative conditions for the project tasks, to yield validated current estimated data and validated historical estimated potential inefficiency contributor data attributable to each of the risk-determinative conditions for the project tasks; calculating by means of one or more of the processors a difference between a current estimated inefficiency factor applied to the validated current estimated data and a projected inefficiency factor applied to the validated historical estimated potential inefficiency contributor data for each of the risk-determinative conditions for each of the project tasks, to yield an initial risk value for each of the risk-determinative conditions for each of the project tasks; receiving from one or more of the user interfaces, and storing in one or more of the data stores, a probability of occurrence for each of the risk-determinative conditions and calculating a quantified value of risk for each of the risk-determinative conditions by multiplying each of the initial risk values by the respective probability of occurrence; receiving from one or more of the user interfaces, and storing in one or more of the data stores, a probability of mitigation success for each of the risk-determinative conditions and any cost of mitigation to be undertaken; calculating by means of one or more of the processors a final risk value for each of the risk-determinative conditions, by multiplying each probability of mitigation success by the respective quantified value of risk for each of the risk-determinative conditions, and summing the resulting product with the cost of mitigation to be undertaken; and generating by means of one or more of the processors a final risk value output configured to enable a representation of the final risk value for each of the risk-determinative conditions to be electronically displayed. Although not required in all aspects of the invention, the computer system software may be configured further so that the process carried out further comprises calculating by means of one or more of the processors adjusted estimated costs, adjusted estimated man-hours and adjusted estimated duration for each of the project tasks, by summing the current estimated costs, current estimated duration and current estimated man-hours for each of the project tasks, with the sum of all of the final risk values for the risk-determinative conditions for each of the project tasks respectively; and generating by means of one or more of the processors an adjusted estimates output configured to enable a representation of the adjusted estimated costs, adjusted estimated man-hours and adjusted estimated duration for each of the project tasks respectively, for the project as a whole, or for both, to be electronically displayed. In some aspects of the invention, the computer system also may further comprise a display configured to receive the final risk value output, the adjusted estimates output, or both, and to display their respective representation(s). Also in some aspects of the invention, it may be preferred that the quantitative adjustments to the current estimated data and the historical estimated potential inefficiency contributor data, be prepared by a process comprising conducting one or more collaborative interviews with a first plurality of personnel experienced in comparable project execution, and that the probability of occurrence for each of the risk-determinative conditions and the probability of mitigation success for each for each of the risk-determinative conditions each be determined by collaborative consensus amongst a second plurality of personnel (which for purposes of all embodiments of this invention, unless otherwise indicated herein, may be the same or different from the first plurality of personnel) experienced in comparable project execution.

In another embodiment of the invention, a computerized method of preparing an industrial turnaround or construction project execution estimate analysis is provided. The method comprises: receiving from one or more computer interfaces, and storing in one or more data stores, current estimated data expressed initially as, or convertible into, one or more of current estimated cost data, current estimated man-hour data and current estimated duration data, attributable to a plurality of risk-determinative conditions for one or more project tasks; receiving from one or more of the computer interfaces, and storing in one or more of the data stores, historical estimated potential inefficiency contributor data expressed initially as, or convertible into, one or more of historical estimated cost data, historical estimated man-hour data and historical estimated duration data, attributable to the risk-determinative conditions for the project tasks; conducting one or more collaborative interviews with a first plurality of personnel experienced in comparable project execution, so as to develop one or more quantitative adjustments to the current estimated data and the historical estimated potential inefficiency contributor data, which quantitative adjustments at least in part account for either anomalous historical risk which is no longer anticipated with respect to the historical estimated potential inefficiency contributor data, or new known risk which is anticipated with respect to the current estimated data, or both; receiving from one or more of the computer interfaces, and storing in the data stores, the one or more quantitative adjustments to the current estimated data and the historical estimated potential inefficiency contributor data attributable to the risk-determinative conditions for the project tasks, and summing, by means of one or more processors in operative communication with the data stores, the quantitative adjustments, if any, respectively with the current estimated data and the historical estimated potential inefficiency contributor data attributable to each of the risk-determinative conditions for the project tasks, to yield validated current estimated data and validated historical estimated potential inefficiency contributor data attributable to each of the risk-determinative conditions for each of the project tasks; calculating by means of one or more of the processors a difference between a current estimated inefficiency factor applied to the validated current estimated data and a projected inefficiency factor applied to the validated historical estimated potential inefficiency contributor data for each of the risk-determinative conditions for each of the project tasks, to yield an initial risk value for each of the risk-determinative conditions for each of the project tasks; conducting one or more collaborations with a second plurality of personnel experienced in comparable project execution, in order to establish by consensus a probability of occurrence for each of the risk-determinative conditions and a probability of mitigation success for each of the risk-determinative conditions; receiving from one or more of the computer interfaces, and storing in one or more of the data stores, the probability of occurrence for each of the risk-determinative conditions and calculating, by means of one or more of the processors, a quantified value of risk for each of the risk-determinative conditions by multiplying each of the initial risk values by the respective probability of occurrence; receiving from one or more of the computer interfaces, and storing in one or more of the data stores, the probability of mitigation success for each of the risk-determinative conditions; computing, by means of one or more of the processors, a final risk value for each of the risk-determinative conditions, by multiplying each probability of mitigation success by the respective quantified value of risk for each of the risk-determinative conditions, and summing the resulting product with any cost of mitigation to be undertaken; and generating, by means of one or more of the processors, a final risk value output configured to enable a representation of the final risk value for each of the risk-determinative conditions to be electronically displayed. In some aspects of the invention, the above computerized method further comprises: calculating, by means of one or more of the processors, adjusted estimated costs, adjusted estimated man-hours and adjusted estimated duration for each of the project tasks, by summing the current estimated costs, current estimated duration and current estimated man-hours for the project task, with an aggregate of the risk values, respectively, calculated for all of the plurality of risk-determinative conditions for the project task; and generating for display, by means of the processors, an output of the adjusted estimated costs, adjusted estimated man-hours and adjusted estimated duration for each of the project tasks. In some particular aspects of the invention, the method further comprises displaying on a display the output of the adjusted estimated costs, adjusted estimated man-hours and adjusted estimated duration for each of the project tasks, for the project as a whole, or for both.

In yet another aspect of the invention, information about the realized inefficiencies in terms of realized costs, realized man-hour and realized duration inefficiencies for each of the risk determinative conditions is fed back into the databases of the system for use in calculating realized inefficiency values (in monetary terms) and realized risk for each of the risk-determinative conditions and the project tasks. Thus, in this aspect, the system of this invention comprises software which is further configured so that, upon its execution, the process carried out by the system further comprises: receiving from one or more of the user interfaces, and storing in one or more of the data stores, realized potential inefficiency contributor data (which typically will be collected, e.g., by monitoring a project task in execution) expressed initially as, or convertible into, one or more of realized cost data, realized man-hour data and realized duration data, attributable to each of the plurality of risk-determinative conditions for the one or more project tasks; calculating, by means of the processors, the difference between the validated historical estimated potential inefficiency contributor data and the realized potential inefficiency contributor data for each of the risk-determinative conditions for each of the project tasks, to yield a realized actual inefficiency value for each of the risk-determinative conditions for each of the project tasks; and calculating, by means of the processors, a realized risk for each of the risk-determinative conditions for each of the project tasks by subtracting the realized actual inefficiency value from the final risk previously calculated respectively for each of the risk-determinative conditions for each of the project tasks.

In some aspects of the invention, the information about the realized inefficiencies in the project which was fed back into the databases of the system to calculate realized inefficiency values and realized risk, is also used as historical, real-world benchmark data in future project analyses run by the system. Thus, in this particular aspect, the process carried out by the system further comprises: employing the stored, realized potential inefficiency contributor data of the one or more project tasks as historical estimated potential inefficiency contributor data and repeating the foregoing steps with respect to current estimated data specific to another set of one or more project tasks of a different project, so as to calculate, by means of one or more of the processors, initial risk values for the one or more risk-determinative conditions of the one or more project tasks of the different project. In this way, the process leverages past project experience and puts that historical information to use in future estimation and execution risk analyses, enabling users to do so across multiple projects, potentially on a massive scale.

These and other embodiments, features and advantages of the subject matter of this disclosure are made even more apparent by the following detailed description, including the accompanying drawings and appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is schematic flow diagram of a process carried out using a system configured and operated in accordance with one aspect of the invention.

FIG. 2 is an output display produced by the system of FIG. 1, illustrating a representation of various data input regarding current estimated (planned) and projected results, regarding a hypothetical project using the system of FIG. 1.

FIGS. 3-14 are output displays produced by the system of FIG. 1, each illustrating a representation of key data in the form of historical potential inefficiency contributor data gathered and input to, and output calculated by, the system of FIG. 1 for a plurality of risk-determinative conditions for the hypothetical project of FIG. 2.

FIG. 15 is another output display produced by the system of FIG. 1, illustrating a representation of initial risk value calculations made by the system for all of the risk-determinative conditions of the hypothetical project of FIG. 2.

FIG. 16 is another output display produced by the system of FIG. 1, illustrating a representation of initial, quantified and final risk calculations across all of the risk-determinative conditions for the hypothetical project of FIG. 2

FIG. 17 is an output display produced by the system of FIG. 1, illustrating a pie chart representation of the initial risk values for the risk-determinative conditions output in the display of FIG. 5.

FIG. 18 is an output display produced by the system of FIG. 1, illustrating a pie chart representation of the quantified risk values for the risk-determinative conditions output in the display of FIG. 5.

FIG. 19 is an output display produced by the system of FIG. 1, illustrating a pie chart representation of the final risk values for the risk-determinative conditions output in the display of FIG. 5.

FIG. 20 is a schematic diagram showing the system of FIG. 1 implemented upon server in operative communication with one or more data stores, and accessible by multiple user interfaces over a communications network, e.g., the Internet.

Like reference numbers or letters employed amongst the various figures are used to refer to like elements or process steps, as the case may be.

FURTHER DETAILED DESCRIPTION OF THE INVENTION

As will now become further apparent, the subject matter of this disclosure enables a very detailed, highly efficient and effective analysis of the risk-determinative conditions involved in various tasks necessary to complete an industrial turnaround maintenance or construction project, in order to provide appropriately validated and risk-weighted adjustments to estimates of task and/or project data such as, e.g., man-hours, duration and cost. The system and method provide validation of current estimated and historical estimated man-hour, duration and cost data, for example, associated with events or conditions typically involved in the relevant project which can impact the itemized and aggregate estimated totals. The validation process uses quantitative adjustments to both current and historical project estimates, such adjustments being derived from both the inputs provided in answering a series of questions about historical project potential inefficiency contributors for each of a plurality of risk-determinative conditions, as well as human input gathered by interviews with experienced personnel. Once validated, the historical and current estimated data for the variable conditions or events are risk adjusted, by taking into account the probability of risk occurrence and the probability of risk mitigation success, both of which are derived from historical experience and human consensus input gathered in collaborative sessions involving experienced personnel. Values are then assigned to the risk associated with the current estimates for the project at hand, rapidly providing a clear picture of the value of probable risk involved in the project as estimated, and revealing the areas of opportunity for risk mitigation and estimation process improvement.

For purposes of this invention disclosure, risk-determinative conditions are those conditions which could impact cost or schedule duration in the project involved, identified from experience on prior projects or industry standards or norms. For the system and method of this invention, the risk-determinative conditions may include, for example:

Extended unit shut down and decontamination

Extended unit Commissioning & Start-up

Poor decontamination for equipment preparation

Peripheral impacts (interruptions due to events outside of the project execution which impact the project cost, duration and/or man-hours)

Unbudgeted permit delays

Unbudgeted scope growth (addenda+discovery)

Labor logistical inefficiency

Regional Economics, Supervision & Crafts

Equipment transition efficiency

Weather delays

Housekeeping delays

Unbudgeted contingency (i.e., Field Change Orders)

Of course, other or additional risk-determinative conditions may exist or be included in a given turnaround or construction project, but the foregoing risk-determinative conditions come into play in the vast majority of industrial turnaround or construction projects.

For each risk-determinative condition, any inefficiency factor ascribed to the condition in a current estimate (planned) to be analyzed is input to the software of the system through a user interface. For each risk determinative condition, a series of questions (also referred to herein as "potential inefficiency contributors") are posed in order to develop historical (planned) inefficiency factor for validated historical projections with respect to each risk determinative condition. The current estimate (planned) data are obtained from the current plan under analysis; namely, the current plan's estimated cost data, man-hour data and duration data. The potential inefficiency contributors are identified, and the historical project inefficiency factors calculated, according to industry norms regarding the sources of manpower inefficiency which exist for typical industrial turnaround or construction projects.

As used in this disclosure, project tasks are steps or subcomponents within the entire project of varying complexity and duration which must be carried out in order to complete the turnaround and/or project. Although not required, the entire project typically will comprise a plurality of tasks, and some risk conditions may or may not apply to all of the tasks within a given project.

Reference should be made to the figures and the following description of one embodiment of the invention, for a complete understanding of the process carried out in one particular, illustrative embodiment of the invention:

Phase I

Typically, a turnaround or construction project owner will develop an estimate (also referred to herein as "current" or "planned" estimate) which should typically include, e.g., total cost, total man-hours, duration, pre-execution man-hours (which are a part of total man-hours), post-execution man-hours (which are a part of total man-hours), contingencies (also known as addenda work scope growth, discovery work scope growth and/or field change orders; which can be a part of cost and/or man-hours), and an inefficiency factor (also referred to herein as an "inefficiency multiple"). In one aspect of this invention, from an input of the estimate (planned) data is calculated a projected cost risk, using a composite cost rate per man-hour applicable to the project ("Composite Cost Rate"), as well as the current estimated (planned) inefficiency factor (converted into man-hours), and a projected inefficiency factor developed pursuant to this invention, each factor being allocated in accordance with this invention to each of a plurality of risk-determinative conditions which are not accounted for, or may be inaccurately accounted for, in the estimate (planned). The calculation of the Composite Cost Rate can be expressed mathematically in the following algorithm: Total Cost ($).+-.Total Man-hours(inclusive of contingencies)=Composite Cost Rate The inefficiency factor provided as part of the initial estimate (planned) is analyzed (through question and answer sessions with a plurality of personnel involved in the execution of the proposed project) to determine whether and, if so, how that initial inefficiency factor was allocated across the risk-determinative conditions when preparing the initial estimate (planned). Those allocations are the subject of scrutiny through validation and additional inputs are provided where necessary to accurately assess the risk-determinative condition and to produce a projected inefficiency factor for each risk-determinative condition.

The aforesaid validation is conducted by making, where necessary, quantitative adjustments, which are those numeric adjustments to current estimated or historical estimated man-hours, current estimated or historical estimated cost and/or current estimated or historical estimated duration for a given risk-determinative condition in a given project task within a project or turnaround estimate under analysis, using the system or method of this invention. The quantitative adjustments account for anomalous historical risk which is no longer anticipated with respect to the historical estimated potential inefficiency contributor data and account for newly known risk which is anticipated with respect to the current estimated data, or both. Historical estimated potential inefficiency contributor data (historical estimated cost data, historical estimated man-hour data and historical estimated duration data) is cost-, man-hour- and/or duration-related estimation data regarding potential inefficiency contributors relevant to the risk-determinative conditions and/or projects in total, realized on past projects executed by the project owner. Validated current estimated data and validated historical estimated potential inefficiency contributor data (the latter also referred to herein as "projected" data) are current estimated (planned) data and historical estimated potential inefficiency contributor data, respectively, net of quantitative adjustments determined to be necessary.

The projected or historical estimated inefficiency factor allocation for each of the risk-determinative conditions, thus calculated, is compared to the initial estimate's (planned) inefficiency factor allocation, respectively. The difference (differential) between the planned and projected inefficiency factor allocation for each risk-determinative condition is multiplied by a number which is equal to the total execution man-hours minus the previously identified inefficiencies (expressed in man-hours) for that risk-determinative condition, thus yielding man-hours attributed to inefficiencies caused by the risk-determinative condition which were not included in the initial estimate (planned). This calculation can be completed by executing software coded to employ the following algorithm: (Total (Planned) Execution Man-hours-Current Estimated (Planned) Inefficiency Man-hours).times.Inefficiency Factor Differential.times.Composite Cost Rate=Initial Risk ($) (IR) The Initial Risk (IR) for each of the risk-determinative conditions may be summed to yield Total Initial Risk for the project. Phase II

The initial risk for each of the risk-determinative conditions is then converted to quantified risk, by evaluating systematically the probability of the respective risk-determinative condition's occurrence. Probability of occurrence (PO) is the probability (having a value between 0 and 1, inclusive) that the initial risk for each risk-determinative condition is realized. This probability of occurrence is assigned through a group collaboration of a plurality of personnel experienced in project execution, preferably by consensus.

Quantified risk (QR) so determined can be calculated again by executing software coded to employ the following algorithmic expression: QR=IR.times.PO also typically expressed in terms of currency, such as dollars.

The quantified risk (or QR) for each risk-determinative condition is then converted to final risk (or FR) by identifying potential mitigation of the occurrence of the risk-determinative condition, expressed as a probability of mitigation success (PMS). PMS is the probability (having a value between 0 and 1, inclusive) assigned to mitigating the quantified risk (or QR) for each risk-determinative condition. This probability is assigned through a group collaboration of a plurality of personnel experienced in project execution, preferably by consensus. Cost of mitigation (or CM) may be factored into determining the probability of mitigation success (PMS), or it may be treated separately, as noted below.

Final Risk (FR) can be mathematically expressed in the following algorithm: FR=(IR.times.PO).times.PMS[optionally+CM] or FR=QR.times.PMS[optionally+CM] with PMS again expressed in terms of currency, such as dollars. If cost of mitigation of risk was not factored into determining the probability of mitigation success initially, then the cost of mitigation may be added to the product of quantified risk multiplied by probability of mitigation success, to arrive at an accurate Final Risk (FR) total. Final Risk (FR) for all risk-determinative conditions can then be summed to arrive at final cost risk value output at the project level, or any selected portion (e.g., task or task category) thereof.

Once final risk values are calculated for each risk-determinative condition of each project task, adjusted estimated costs, adjusted estimated man-hours and adjusted estimated duration for each of the project tasks may be further calculated by summing the current estimated costs, current estimated duration and current estimated man-hours for each project task with the final risk values calculated for all of the risk-determinative conditions for the respective project task, and generating for display an output of the adjusted estimated costs, adjusted estimated man-hours and adjusted duration for each of the project tasks, for the project as a whole, or for both.

Phase III

In order to take full advantage of the power of the decision-making information provided by systems of the invention, in some aspects of the invention the process carried out using the system will further entail gathering information about the actual execution outcomes for a given project for which pre-execution estimation risk analysis was conducted, in order to assess the accuracy of the initial analysis and to feedback the realized results into the system, in order to utilize the actual performance data in establishing margins of error in the predicted risk and to enhance the accuracy of projected inefficiencies and projected risk in future estimate analyses. The accuracy of the system and method is further enhanced from repeated actual performance data feedback into, and storage and use of such data in, the system over time. It also enables trending and benchmarking analyses of projects in multiple datasets across or within industries, or project-specific criteria such as, e.g., owner identity, manager identity, geographical location, size, type, financial magnitude, man-hour magnitude, etc. Thus, the software of the system may be further programmed so that the process carried out further comprises: receiving from one or more of the user interfaces, and storing in one or more of the data stores, realized potential inefficiency contributor data (which typically will be collected, e.g., by monitoring a project task in execution) expressed initially as, or convertible into, one or more of realized cost data, realized man-hour data and realized duration data, attributable to each of the plurality of risk-determinative conditions for the one or more project tasks; calculating, by means of one or more of the processors, the difference between the validated current estimated potential inefficiency contributor data and the realized potential inefficiency contributor data for each of the risk-determinative conditions for each of the project tasks, to yield a realized actual inefficiency value (in monetary terms) for each of the risk-determinative conditions for each of the project tasks; and calculating, by means of one or more of the processors, a realized risk for each of the risk-determinative conditions for each of the project tasks by subtracting the realized actual inefficiency value from the final risk previously calculated respectively for each of the risk-determinative conditions for each of the project tasks.

The sum of the realized risks (in monetary terms) for the risk determinative conditions of the project tasks should equal the realized risk (in monetary terms) on the project. If the realized risk in monetary terms is greater than zero, then the system will reflect that the previously calculated final risk (before the project was executed) did not account for all risk in advance. The realized actual inefficiency values and the realized risk values for each of the risk-determinative conditions, will enable a user to understand the conditions which gave risk to the realized risk, so that such risk determinative conditions may be further studied for risk mitigation opportunities on future projects. In addition, the realized potential inefficiency contributor data can be taken into account on future projects, when such data is used as the "historical" estimated potential inefficiency contributor data. Thus, in some aspects of the invention, the process carried out by the system further comprises: employing the stored, realized potential inefficiency contributor data of the project tasks as historical estimated potential inefficiency contributor data and repeating the foregoing steps with respect to current estimated data specific to another set of one or more project tasks of a different project, so as to calculate, by means of one or more of the processors, initial risk values for the one or more risk-determinative conditions of the one or more project tasks of the different project. Over time, collections of projects' data may enable realized data values to be averaged or trended for further use in the analyses. In this way, the system "learns" from the experience of realized project outcomes, and uses the data born from experience to improve accuracy of the results of Phases I & II of the system's evaluation of future project estimates, by automatically adjusting embedded parameters (historical estimated potential inefficiency contributor data) with more results actually achieved on previously analyzed projects and stored within the system's data stores.

Embodiments of the subject matter and the functional operations described in this specification can be implemented in digital electronic circuitry, or in computer software, firmware, or hardware, including the structures disclosed in this specification and their structural equivalents, or in combinations of one or more of them. Embodiments of the subject matter described in this specification can be implemented as one or more computer program products, i.e., one or more modules of computer program instructions encoded on a tangible program carrier for execution by, or to control the operation of, data processing apparatus. The tangible program carrier can be computer-readable medium, such as a machine-readable storage device, a machine-readable storage substrate, a memory device, or a combination of one or more of them.

The term "data processing apparatus" encompasses all apparatus, devices, and machines for processing data, including by way of example a programmable processor, a computer, or multiple processors or computers. The apparatus can include, in addition to hardware, code that creates an execution environment for the computer program in question, e.g., code that constitutes processor firmware, a protocol stack, a database management system, an operating system, or a combination of one or more of them.

A computer program (also known as a program, software, software application, script, or code) can be written in any form of programming language, including compiled or interpreted languages, or declarative or procedural languages, and it can be deployed in any form, including as a stand-alone program or as a module, component, subroutine, or other unit suitable for use in a computing environment. A computer program does not necessarily correspond to a file in a file system. A program can be stored in a portion of a file that holds other programs or data (e.g., one or more scripts stored in a markup language document), in a single file dedicated to the program in question, or in multiple coordinated files (e.g., files that store one or more modules, sub-programs, or portions of code). A computer program can be deployed to be executed on one computer or on multiple computers that are located at one site or distributed across multiple sites and interconnected by a communication network.

The processes and logic flows described in this specification can be performed by one or more programmable processors executing one or more computer programs to perform functions by operating on input data and generating output. The processes and logic flows can also be performed by, and apparatus can also be implemented as, special purpose logic circuitry, e.g., an FPGA (field programmable gate array) or an ASIC (application-specific integrated circuit).

Processors suitable for the execution of a computer program include, by way of example, both general and special purpose microprocessors, and any one or more processors of any kind of digital computer. Generally, a processor will receive instructions and data from a read-only memory or a random access memory or both. The essential elements of a computer are a processor for performing instructions and one or more data stores, normally in the form of memory devices for storing instructions and data. Generally, a computer will also include, or be operatively coupled to receive data from or transfer data to, or both, one or more mass storage devices for storing data, e.g., magnetic, magneto-optical disks, or optical disks. However, a computer need not have such devices.

Computer-readable tangible media upon which is encoded machine-readable software in accordance with this disclosure should be suitable for storing computer program instructions and data, which may be same as or different from the data store. Suitable examples of such media (and data store) include all forms of non-volatile memory, media and memory devices, including by way of example semiconductor memory devices, e.g., EPROM, EEPROM, and flash memory devices; magnetic disks, e.g., internal hard disks or removable disks; magneto-optical disks; and CD-ROM and DVD-ROM disks. The processor and the memory can be supplemented by, or incorporated in, special purpose logic circuitry.

To provide for interaction with a user, embodiments of the subject matter described in this specification can be implemented on a computer having a display device, e.g., a CRT (cathode ray tube) or LCD (liquid crystal display) monitor, for displaying information to the user and a user interface, such as, e.g., a keyboard and a pointing device, e.g., a touchscreen, mouse or trackball, by which the user can provide input to the computer. Other kinds of devices can be used to provide for interaction with a user as well; for example, feedback provided to the user can be any form of sensory feedback, e.g., visual feedback, auditory feedback, or tactile feedback; and input from the user can be received in any form, including acoustic, speech, or tactile input.

The following Example further illustrates the data input and calculations undertaken in a particular embodiment of the invention for a hypothetical project. It should be appreciated that this example is merely to illustrate the calculations undertaken by the system and method of one embodiment of the invention, and is not intended to limit the scope of the invention in any way.

EXAMPLE

FIG. 1 shows a flow diagram of the steps carried out by the system and method according to one embodiment of the invention. FIGS. 2-19 illustrate the computer displays which are generated from the inputs and outputs of the computerized system in a computerized analysis of a hypothetical turnaround project for a refinery. As noted in the flow diagram of FIG. 1, data from the owner's initial project plan (current estimated man-hours, cost and duration) for the overall project are obtained and input into the system, for display as shown in FIG. 2. A composite man-hour rate (cost per man-hour) may be determined from this data, and is displayed in FIG. 2 as $150. Current estimated data and historical estimated data are examined for inefficiencies created by several risk-determinative conditions such as, for example, labor logistical inefficiencies. To do so, data in the form of answers to a series of questions regarding potential inefficiency contributors ("potential inefficiency contributors")(e.g., activity duration) and values used to calculate such potential inefficiency contributors, such as shift duration, number and duration of breaks/lunch and number and duration of safety meetings, are entered into the model and made available for display, as illustrated in FIGS. 3-14. A historical estimated (projected) inefficiency factor for the risk-determinative condition is calculated from the inputted potential inefficiency contributors, in this case 0.2083 for labor logistical inefficiencies, as seen on FIG. 3. The executing software calculates the differential between the calculated projected inefficiency factor (0.2083) and the current estimated inefficiency factor (0.1000) used in the current estimate and allocated to this particular risk determinative condition. That differential (rounded to 0.108 in FIG. 3) is then multiplied by the Bare Turnaround (TA) Execution Man-hours (Total Forecasted TA Execution Man-hours minus Inefficiency Man-hours Included in Baseline Man-hours in the display of FIG. 2.) thereby yielding Labor Logistical Inefficiency Man-hours of 13,481, as noted in the display of FIG. 3. The Labor Logistical Inefficiency Man-hours are then multiplied by the Composite Rate from FIG. 2 to yield Initial Cost Risk of $2,022,222 for the Labor Logistical Inefficiency Category as listed in FIGS. 16 and 17. The Initial Risk for Labor Logistical Inefficiency listed in FIG. 16 is then examined by group collaboration of a plurality of personnel experienced in like projects, to determine and assign (preferably by consensus) a Probability of Occurrence (0.70 or 70% as noted in the display of FIG. 16). The product of that probability multiplied by $2,022,222 yields the Quantified Risk ($1,415,556) as displayed in FIGS. 16 and 18. Group collaboration of the same personnel is also used to determine probability of mitigation success (gauging the probability of successfully mitigating the risk), and to estimate mitigation cost (estimated at 0 in this example, as seen from FIG. 16). Upon entry of the probability of mitigation success into the software, the system further multiplies that probability (in this case 0.3 or 30% as shown in FIG. 16) by the Quantified Risk, yielding a calculated Final Risk of $990,889, as seen from the displays of FIGS. 16 and 19.

This process is likewise conducted for each of the other risk-determinative conditions (listed out at FIGS. 4-14), using values input for the potential inefficiency contributors relevant to each risk-determinative condition. As seen from FIG. 16, the initial, quantified and final risks may be totaled for the project as a whole and/or displayed in itemized fashion. FIGS. 17, 18 and 19 illustrate how the various levels of cost risk, initial, quantified and final, respectively, created by each risk-determinative condition and displayed at FIG. 16, may be compared visually, for example by means of a pie chart. As displayed in FIG. 2, data relevant to this Example could further provide adjusted current estimated cost for the project as a whole, by summing the initial total cost of the project ($36,000,000 from FIG. 2) with the final risk value ($5,903,987 from FIG. 16 as shown in FIG. 2) ascribed to all of the risk-determinative conditions, for a total adjusted current cost estimate of $41,903,987, as show in FIG. 2.

As illustrated at FIG. 20, in one aspect of the invention, the system is deployed as a programmed computer server 20 equipped with one or a plurality of processors in operative communication with one or more data stores 10. Server 20 receives and processes input from and sends output to one or a plurality of displays of one or a plurality of remote user interfaces in the form of computers 30 via a telecommunications network, e.g., the Internet. In the illustrated system, the interfaces of computers 30 will typically display the output of a browser or a similar software application to facilitate a user's interface with the system, including the input of data to the system via a touch screen, keyboard, mouse or the like and the display of outputs sent to the interfaces by server 20, using conventional computer network transmission protocols and wired or wireless network components. In this aspect, the system enables the provision of online services to multiple users and customers at locations remote from centrally-managed processors and data stores. Aggregation of data collected in the data stores across project tasks, projects and groups or sources of projects over time enable users of the system to query and mine the data stores for trends and perform other statistical analysis and to level the historical data archive to decrease final risk values and realized risk on future project manpower estimates.

While this specification contains many specific implementation details and may describe particular embodiments of the subject matter in great detail, these should not be construed as limitations on the scope of any invention or of what may be claimed, but rather as descriptions of features that may be specific to particular embodiments of particular inventions. Other embodiments are within the scope of the following claims. Certain features that are described in this specification in the context of separate embodiments can also be implemented in combination in a single embodiment. Conversely, various features that are described in the context of a single embodiment can also be implemented in multiple embodiments separately or in any suitable subcombination. Moreover, although features may be described above as acting in certain combinations and even initially claimed as such, one or more features from a claimed combination can in some cases be excised from the combination, and the claimed combination may be directed to a sub-combination or variation of a sub-combination.

Similarly, while operations are depicted in the drawings in a particular order, this should not be understood as requiring that such operations be performed in the particular order shown or in sequential order, or that all illustrated operations be performed, to achieve desirable results. For example, the processes depicted in the accompanying figures do not necessarily require the particular order shown, or sequential order, to achieve desirable results. In certain circumstances, multitasking and parallel processing may be advantageous. Moreover, the separation of various system components in the embodiments described above should not be understood as requiring such separation in all embodiments, and it should be understood that the described program components and systems generally can be integrated together in a single software product or packaged into multiple software products.

Except as may be expressly otherwise indicated, the article "a" or "an" if and as used herein is not intended to limit, and should not be construed as limiting, the description or a claim to a single element to which the article refers. Rather, the article "a" or "an" if and as used herein is intended to cover one or more such elements, unless the text expressly indicates otherwise. In addition, the invention may comprise, consist, or consist essentially of the materials, components and/or steps recited herein.

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