

A NEW MODEL FOR THE MANAGEMENT OF PORTFOLIOS OF PROJECTS

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ABSTRACT

This paper addresses the issue of implementing a MIS which is able to identify significant projects and provide feedback for their control. These significant projects are those which have most impact on the overall performance of the portfolio of projects. The key issues which are addressed are the performance of a MIS based on traditional principles and the subsequent search for heuristics which would make this system effective and efficient.

1 INTRODUCTION

It has long been a fundamental economic principle of the Government of Hong Kong (HKG) that “public expenditure should not grow faster than the trend growth rate of the economy over the medium term” (Arnold 1995). Furthermore, capital spending is their preferred way of using public income for economic good: other government programmes have an enduring recurrent cost. In the period 1982-1993, Hong Kong’s GDP grew at a rate of more than seven per cent per annum; in the same period the output of the construction industry grew at an average of nine per cent. Over the past decade these factors have combined to promote spending on capital infrastructure which is economically and visually breathtaking.

Historically, the expenditure of the HKG on infrastructure has accounted for 30-40% of construction output. It is not surprising that in this hot-house climate for capital growth, construction has always made a major contribution to Hong Kong’s economy. It has been estimated that real estate, property and construction contribute about 24% of Hong Kong’s GDP (see Rowlinson & Walker, 1995).

This paper investigates the management of one of the largest elements of HKG’s infrastructure spending, the public works programme (PWP) of projects. In particular it looks at the information management needs of such a huge portfolio of projects, with particular emphasis on identifying those projects that are significant to the success of the portfolio, i.e. those which affect the overall performance of the PWP. The key issue to be addressed in the management of the PWP is the monitoring of projects to ensure expenditure meets budget projections. Unusually, in a cash-conscious-world, the focus of HKG attention has been ensuring that their budget is not under-spent.

2 THE PUBLIC WORKS PROGRAMME (PWP)

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The work being undertaken on Hong Kong's new airport projects (ACP) is well publicized in construction journals but the PWP is a much larger, recurrent programme which has been paid scant attention. The portfolio is diverse, including 63 types of infrastructure project according to HKG classification, and encompasses the work of seven works public works departments (see Table 1) which service eleven "ministries" and numerous quasi-government organizations. HKG is thus a large, unwieldy, highly differentiated and bureaucratic organization which has within it all the participants needed for the development of large-scale infrastructure. The Works Branch (WB) of the Secretariat of the HKG has the unenviable task of seeking to achieve co-operation among these differentiated parties. The objective is delivery of the PWP to satisfy the owner of the PWP. In simple terms this means, the aggregate of expenditure on the fifteen hundred individual projects must match the owners budgeted cashflow for the PWP.

The scale of annual expenditure is exhibited in Table 1. It provides a summary of indices which reflect the state of the economy and consequent spending on the PWP.

Year	Forecast GDP (prev year)	Inflation (prev year)	Un-employment	Capital Expenditure (% diff to prev year)	Outlook for the PWP
88-89	5% (13.5)	7% (5.5%)	1.4%	\$10.18 billion (+32%)	Bearish
89-90	6% (7.5%)	7.5% (7.5%)	1.35%	\$14.5 billion (+33%)	Bullish
90-91	3% (2.5%)	8.5% (10.1%)	1.6%	\$20.82 billion (+30%)	Bullish
91-92	3.5% (2.4%)	8.5% (9.8%)	2.0%	\$25.75 billion (+24%)	Bearish
92-93	5% (4%)	9.5% (9.6%)	2.2%	\$29.03 billion (+13%)	Bullish
93-94	5.5% (5.0%)	9.5% (9.4%)	2.15%	\$31.57 billion (+9%)	Bullish
94-95	5.5% (5.5%)	8.5% (9.4%)	2.15%	\$33.05 billion (+5%)	Bearish
95-96	5.5% (5.5%)	8.5% (8.1%)	3.5% <i>(oct-95)</i>	\$36.5 billion (+10%)	Bullish

Table 1: From Budget Speeches 1988/89-1995/96

There are eight public works departments, each focused on an engineering discipline, who undertake over 1,500 projects for a number of policy secretaries. Policy secretaries are the clients for infrastructure projects. The system is highly differentiated with each department having different staffing levels, workloads, locations, and each undertaking different types of work as exhibited on Table 2.

3 THE PWP PROCESS

The PWP Process is the way in which HKG goes about procuring projects. Like many government bodies, as opposed to private sector clients, the organization includes participants who play different roles in the process, i.e. banker, client, client advisor, consultant, construction supervisor. This is idealized in Figure 1, the model is typical of public sector organizations responsible for infrastructure development. The key issue addressed by the HKG, is how can this complex process best be managed.

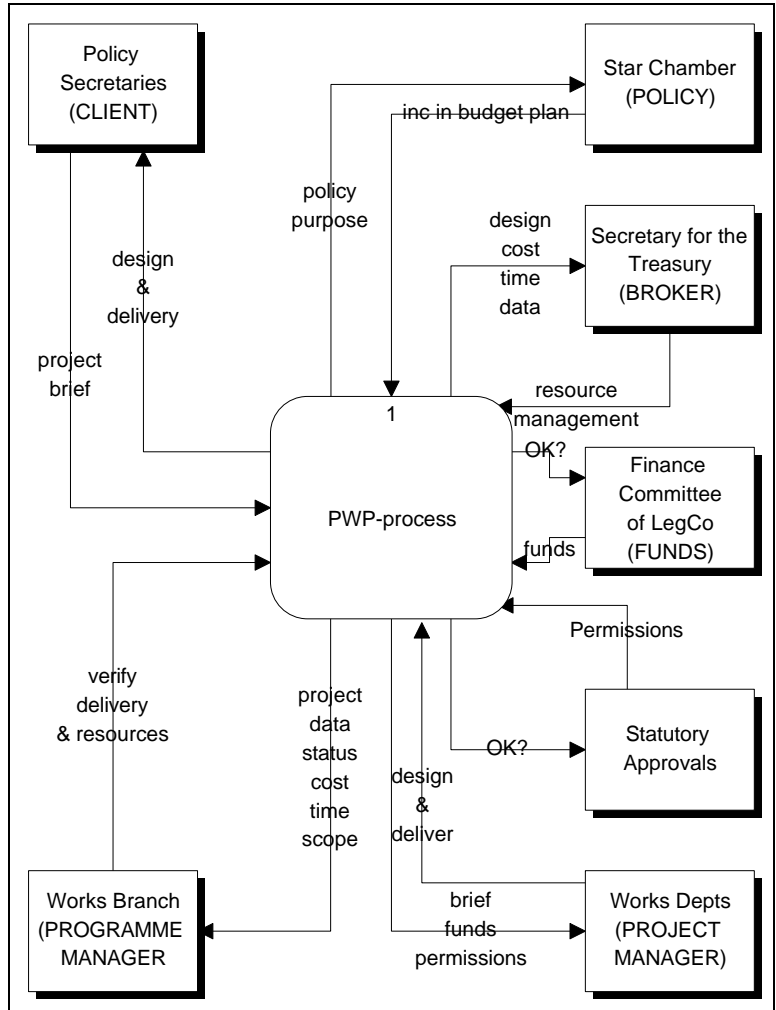


Figure 1 Participant roles in the PWP

Attribute	Architectural Services Department	Civil Engineering Department	Drainage Services Department	Environmental Protection Department	Home Affairs Department	Highways Department	Territory Development Department	Water Supplies Department
Nature of work	government buildings	airport, port, marine and geotechnics	water and sewerage drainage	waste management	regional small works	roads, bridges and railway planning	land formation and urban development	water works
Staffing								
<i>professional</i>	458	320	175	129		314	138	334
<i>technical</i>	497	465	134	386		339	219	256
<i>supervisors</i>	690	209	224	53		560	12	411
Dispersion								
<i>No. buildings</i>	2	2	3	5	3	4	5	4
<i>No. floors</i>	14	16	9	13	7	11	9	12
Clients	12	5	1	1	1	6	5	3
Expenditure Programmes	5	2	2	3	1	4	2	4
No Projects	694	86	90	41	30	165	276	137
Estimated Value <i>(HK\$ millions)</i>	\$ 55,449	\$ 19,842	\$ 13,009	\$ 13,058	\$ 1,736	\$ 38,174	\$ 70,227	\$ 19,897
Value Range <i>(HK\$ millions)</i>	\$ 1 - 3,966	\$ 1 - 3,215	\$ 1 - 1,460	\$ 1 - 1,876	\$ 5 - 276	\$ 2 - 8,247	\$ 1 - 3,140	\$ 1 - 1,955
Mean Value <i>(HK\$ millions)</i>	\$ 82	\$ 231	\$ 148	\$ 318	\$ 58	\$ 231	\$ 254	\$ 145
Median Value <i>(HK\$ millions)</i>	\$ 38	\$ 65	\$ 45	\$ 61	\$ 30	\$ 52	\$ 45	\$ 52
Mode Value <i>(HK\$ millions)</i>	\$ 11	\$ 6	\$ 20	\$ 11	\$ 25	\$ 35	\$ 17	\$ 22
S.D. Value <i>(HK\$ millions)</i>	\$ 536	\$ 471	\$ 255	\$ 506	\$ 69	\$ 724	372	\$ 281

Table 2: Exhibiting the differences and differentiation in the works departments

4 AN OPEN SYSTEM APPROACH TO PORTFOLIO MANAGEMENT

No organization can exist as if in a vacuum, hence the PWP Process has to adapt to the changing economic, financial, cultural and political environments. Thus, the PWP is viewed as an open system as idealized in Figure 2. (see Kast and Rosenzweig, 1985). The scale of the organization and the PWP themselves impose further environmental effects on the PWP which must be included in the open system concept. These effects are: the global-environment surrounding the whole of the organization and process; the organizational-environment which influences how the portfolio and projects are dealt with; and the intrinsic-environment of the portfolio which is dynamically changing due to varying attributes of the many projects as they move through their life-cycles.

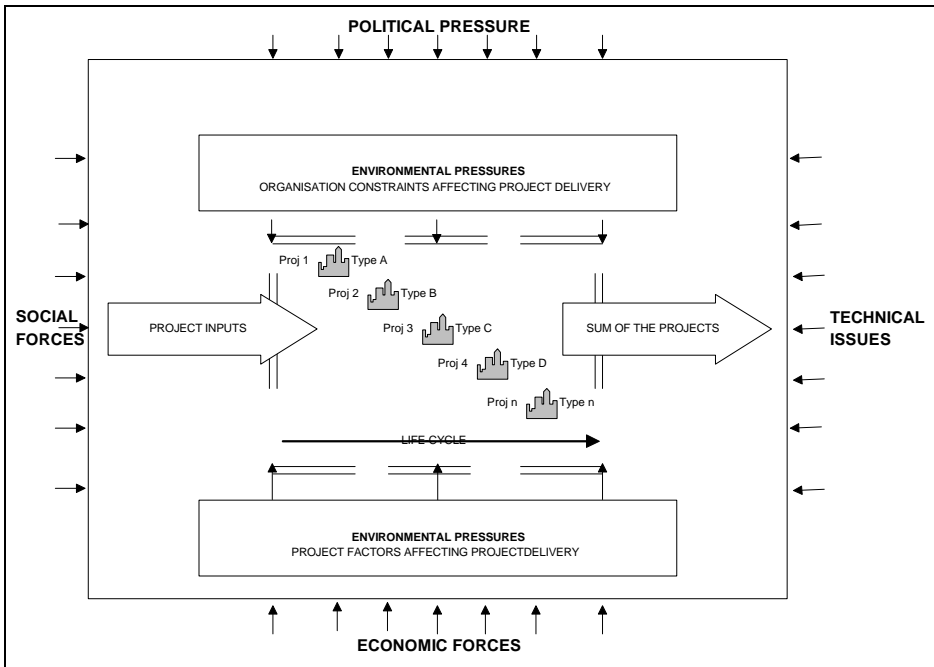


Figure 2 The PWP-process as an open-system

5 PROBLEMS WITH THE PWP

If the environment changes then open-system theory requires the system to evolve so as to prosper under the new circumstances. Hong Kong has a fine reputation for quick reaction to changing environmental forces. This was further demonstrated in the early 1990's when environmental pressures caused fundamental change to the PWP.

5.1 Underspending

In fiscal year 1991-92 expenditure was 39% below budget and 24% below budget in 1992-93. The Legislative Council (Legco) pointed out that this US\$635M underspend could have been used for social needs or, indeed, the taxes not collected at all. Urgent remedy was demanded as the Governor of Hong Kong announced a 44% increase in infrastructure spending in the years up to 1997.

5.2 Responsibility

Responsibility is crucial to remedy. Examination of the PWP open system shows that the Financial Secretary dictates the scale and content of the annual public works budget and is thus the *de facto* 'owner' of the PWP. The Secretary for Works is assigned the role of the programme manager for the PWP by the 'owner'. His task, *inter alia*, is to ensure that overall the cashflow targets of the PWP are met.

This responsibility was laid firmly on the shoulders of the Secretary for Works as the Financial Secretary told Legco in his 1993 budget address. He also announced that fundamental change in the management of the PWP was a political necessity.

. . . it has become clear that we need new measures to ensure . . . that overall management of public works becomes more unified. . . I have taken steps to place with the Secretary for Works overall responsibility for the Public Works Programme . . . Our objective must be to increase substantially our capacity to deliver projects on time and within budget . . . the Secretary for Works [will] carry out an urgent review. . . He will look beyond the government's ranks for advice. (MacLeod, 1993)

A study commissioned from McKinsey Corporation (1994) recommended *inter alia* the installation of a public works management system (PW_MS) to provide flexible and decision oriented access to information at all levels for PWP participants. This was seen as a vital part of the remedy that would bring about shared values, common-goals, and a commitment to project management that would enable the delivery of the PWP as a whole.

6 THE PUBLIC WORKS MANAGEMENT SYSTEM (PW_MS)

PW_MS was developed very rapidly to fulfill an urgent need to bring the PWP into line with its budget. The system developed, described below, relied on a conventional approach which treated all projects in the same way. As it is applied to a large, diverse portfolio of projects the monthly cycle of data collection and analysis is an onerous burden.

6.1 Portfolios of Projects

Management of large portfolios of projects depends on sorting a mass of data to identify and prioritize those issues most in need of management attention. It is made more difficult by increases in the scale, variety, and the complexity of the constituent projects. Tools are used to overcome these difficulties. Techniques are applied to deliver projects successfully. The secret of what tool to use, and what technique to apply, lies in the composition of the portfolio.

The 'tool' commonly used to handle the mass of data is a management-information-system (MIS). Such systems process a large amount of data regularly gathered from the diverse portfolio of projects. They synthesize it to produce timely analyses of project progress compared to the plan. These provide a global overview of events as they occur. Given adequate interpretation these analyses identify significant issues from among unimportant ones. To do this the MIS must contain comprehensive, consistent data frequently

taken from all projects to give an early warning of adverse trends. MIS are good at this, but they are also inflexible and unintelligent. They cannot interpret information except in a severely constrained algorithmic fashion and cannot discern emerging problems, although they can make comparisons and note exceptions. The problem with an MIS is that it treats projects in a uniform manner even though each project is unique.

6.2 Project Management Philosophy

Given that the objective of the PW_MS is to improve the delivery of the PWP it must provide timely and consistent data and support a project management philosophy, i.e. regular, detailed reporting. This cyclic process is shown below in Figure 3. It requires:-

- (a) project planning from the outset, so that only viable and defined projects are undertaken;
- (b) those individuals responsible for activities to be identified so they can be assisted and held accountable for their work; and
- (c) that progress must be measured against a baseline plan with deviation noticed early.

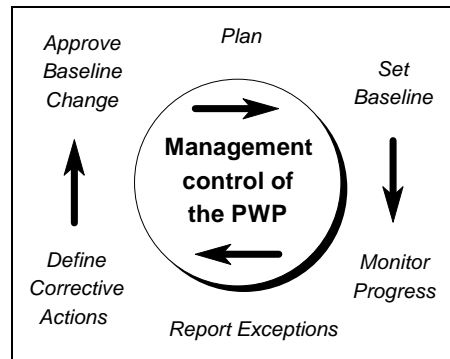


Figure 3 PWP cycle of management control

For this to be successful, baselines must be established which state the scope, time and cost performance of each project. That in itself is straightforward, although it is a logistical problem due to the scale of the PWP. A greater problem arises due the frequent use of partial work assignment. A process the HKG calls 'entrustment'. As already noted, the PWP is multi-project and multi-participant, however a further complication is that entrustment makes it multi-managed. Different elements of a project can be undertaken by different works departments. A hierarchical work-breakdown-structure based on the smallest indivisible element of work, consistent with the nature of the portfolio, is needed to permit progress information to be brought together to provide an entire picture of progress on the project. Combining these as appropriate provides information on the project, on the expenditure programme, on the client portfolio(s), or on the PWP as a whole.

Meeting the demands of multi-project, multi-participant, and multi-management portfolios across a large territorial area is the challenge faced by HKG. It is not a unique problem. The idealized open-system described is a stereotype found in other public sector bodies. It is therefore interesting that HKG's search for established solutions to the problem was unsuccessful. Facing severe political pressure to remedy problems with the PWP they took a leap in the dark to bring about a management-information-system which would serve project and portfolio, integrate the differentiated participants and permit multi-management of large development projects.

7 CONFIGURATION OF THE PW_MS

The PW_MS is built on a wide-area-network of terminals. Clustered around a star-configuration of application servers all of which are connected to a central logical database. The high degree of entrustment involved in the PWP dictated that this should be so.

PW_MS software has routines for the planning, reporting and monitoring of the cost, time and scope aspects of each project in the PWP. It establishes a fixed plan for each project and provides an audit trail of progress towards completion. The data in the system can be readily combined to provide summary reports of portfolios of projects, such as by programme area, or department. This requires comprehensive data to be stored for each project and the many sub-elements of work within each project. This use of project level data and sub-level 'work-package' data provided a MIS to meet the HKG requirement, but the scale of the PWP plus the work-package concept means the logistical burden of data maintenance is very large. At present there are fifteen hundred projects and over three thousand work packages in the PWP, each requiring monthly data up-dating.

PW_MS had to be in operational use within months of the Financial Secretary announcing his determination for a quick remedy. This did not provide adequate time for a detailed approach to system building, therefore PW_MS was not implemented according to structured-systems-analysis-design-methodology (SSADM) practice. Instead a proprietary software was chosen which was thought to be a reasonable fit to the functional requirements of the PWP-process. The software was modified where necessary and put into use as a prototype before a larger scale system was built from it. This is a prototyping short-cut compared to the customary SSADM approach. The idea works if the functions to be performed in the PW_MS are available in a suitable proprietary software. This was thought to be true of a software which conformed to industry-standard project management practices. Unfortunately the processes used by government to manage the PWP do not fully conform to industry standards and the PW_MS needed more software modification than is desirable. The outcome is unsatisfactory. Extensive customization leaves the PW_MS a bastardized version of a commercial product which requires constant maintenance by the vendor to keep it up to date. Only the vendor can do this because they keep secret the knowledge of how the product works. This protects against intellectual piracy, but prevents users maintaining the system themselves. This dependence is expensive and inhibits further development of the system.

8 MANAGEMENT INFORMATION SYSTEM (MIS) PROBLEMS

A prototype PW_MS was rapidly installed by HKG, based on an off-the-shelf software package. The combination of these two attributes has obviously lead to a less than perfect solution to the problem posed. However, more deep seated problems exist and these are related to the traditional views of project management information systems. The applicability of these views to the solution of the PWP problem is questioned.

8.1 Traditional Views

As already explained, management of portfolios of projects has a dependency on systematic information processes. Cleland and King (1983) itemize fourteen requirements for an 'ideal' project-management-information-system (PMIS). Ideal in their view because it is conceived to serve the organization as a multi-project planning system and, at the same time at the lower level, as a project-management tool. These requirements are robust and the objective is still valid today, it is exactly the ambition for the PW_MS. Cleland and King's

PMIS calls for uniformity of data, standardized procedures and data-flow in order to provide a synthesis of data which delivers appropriate information to various management levels. They fail to see difficulty in matching portfolio-level functionality with varied project management requirements. Their model has become the stereotype MIS. The question is, does it make sense to depend on uniformity of data and standardized approaches when the issues are non-uniform, requiring unique solutions.

8.2 Beyond the Stereotype

Horner (1991) has undertaken a number of researches into construction estimating and find it equally unreasonable to estimate the cost of every item in a bill of quantities with equal care. They say the time taken to accurately estimate a rate for items of insignificant value is not worth the effort. They developed simple heuristics based on cost-significance which substantially reduces estimating effort at a minor loss of accuracy. In a like manner, analysis of the characteristics of the PWP will result in rules which identify significant issues that have most impact on achieving portfolio objectives set by the organization. These heuristics pin-point those projects that deserve most attention from management.

If such rules could be coded into an MIS it could become selective in it's demand for detailed data. With an MIS able to discern emerging issues from coarse-data it will be cost-effective to frequently re-evaluate which projects require finer-detailed data and to demand it only when necessary. The MIS would be an adaptive tool, sensitive to changing circumstances. With it, project management effort could be deployed like a 'rapier', targeted with deadly effect. Management attention could then be more effective by being focused on critical issues and the cost of decision-support systems enabling this precise effect could be reduced, resulting in a cost-saving in return for a more rewarding output.

This concept may be novel but portfolio management is not a new subject for research: Morris (1994) writes of a diverse array of projects needing to be managed together because they each influence the goals of the whole organization and share resources. They may, or may not, be inter-dependent. Lonergan (1994) mentions the programme-manager as delivering, through the successful completion of many projects, the objectives and operational aims of the business strategy of the organization. However, both authors then go on to describe the stereotype approach: consistent gathering of project information irrespective of project diversity. Turner and Speiser (1992) also provide like examples of uniform information management being used to optimize some management constraint.

8.3 Problem Identification

The expedient solution adopted by the Government of Hong Kong of an algorithmically-based project management software to their large and diverse portfolio of projects exposes a fundamental dichotomy between the 'tool' and the 'technique' used in this stereotype. Stated briefly, an MIS cannot overcome an inconsistent management style; the style must be varied to cater to diversity within the portfolio. However, an MIS is essential to identify which projects most require management attention. Thus, the MIS must be enhanced so that it can identify significant projects which have most impact on the portfolio of projects.

8.4 Algorithm vs Heuristic

The suggested enhancement of the MIS model comes in the addition of an heuristic component to the algorithmically based system. The heuristics are determined by analysis of the portfolio open-system. It is expected that a number of these will be identified as defining what is truly significant for successful delivery of the portfolio.

For example, in Hong Kong the demand for land is high. Provision of land for construction is difficult. The need for land thus becomes an important factor in the project. The land problem varies from project to project. It is more difficult to allocate areas of land for construction sites when they are larger than one plot of Crown Land. This problem is normal for linear works projects, such as highway or drainage projects, but uncommon for buildings and other such compact construction. A heuristic which identifies which projects have a low requirement for Crown Land and those which have a high requirement enables their relative significance to the portfolio as a whole to be objectively assessed.

However such a heuristic can only be determined from analysis of the PWP-process and it's susceptibility to environmental pressures. Taking the land example a stage further. In Hong Kong the resumption of land in the possession of private lessees is considerably more difficult than taking possession of Crown Land. This problem is particularly serious for a number of large and politically important projects. 'The river re-training scheme to alleviate flooding in the New Territories'; 'the western corridor railway', and 'the improvement to Castle Peak Road' are three major projects which are jeopardized by the need to resume large tracts of privately held land.. The costs involved are also significantly high. Thus a further heuristic on the issue of land is the number of privately leased plots involved. Furthermore, the demand for land far exceeds the ability of the Lands Department to provide it. Works Branch and the Lands Department are now introducing rules which set priorities to be given to resumption and clearance of land for public works projects. The three heuristics must be reviewed in combination if the projects in the portfolio which most suffer land difficulties are to be identified.

8.5 Resolution of Heuristics

Whilst it is conceivable that the heuristics could be manually resolved for each project to indicate, at any given moment, those that are significant to PWP success and those that are high risk, this is not a practical approach.

The projects are each moving through their life-cycle with individual circumstances constantly changing. A portfolio of merely a few projects would be sufficiently dynamic to make it difficult to use manual methods for resolution of the heuristics formulated for the PWP. A MIS such as the PW_MS is essential for this.

Examination of the formatted data within PW_MS (Futcher, 1996) shows that one of the two heuristics which identify the significant projects within a portfolio can be coded into the PW_MS. The other one, which is less objective and arguably least important, cannot be resolved within PW_MS unless specific data is added to the PW_MS database. This data is simply an objective measure of the political importance of each project in the portfolio. It is either a 'yes' or a 'no'. It merely indicates that the project falls within this category of significance. This attribute cannot be flagged by algorithmic resolution of other data within the database: it must be externally assigned. The flag remains constant throughout the life-cycle of the project unless external circumstances change. This test of significance is not intrinsic to the properties of the project.

Furthermore, examination of the open-system environment pertaining to HKG and the PWP derived twelve other heuristics which test for issues deserving special project management attention. Four of these can be resolved with data held within the PW_MS. The eight which cannot be resolved require data which is unique to that attribute and must be provided just for that purpose. It is not possible to derive the data from other information residing in the database. The uniqueness of the required data, the specifics of the interpretation is of the nature of a 'knowledge-based' system.

The PW_MS, like many other MIS used in the construction industry, was originally developed to support the scope, cost and time-planning aspects of project management. It provides a useful means of recording a lot of data on these aspects but has limited ability to derive meaningful information from it, other than to make rudimentary selections and comparisons. The software industry has developed the database enquiries possible with such systems to the extent that reports generated by them are sophisticated, although limited to non-interpretative use of rigidly formatted data.

The PW_MS contains data which gives it the potential to select the projects within the portfolio most significant to the owner's objective for spending to match medium-term budgetary provision. It did not contain other data that makes it possible to resolve the majority of the algorithms which would identify those projects facing a high-level of risk. Unique qualitative and quantitative data relating to specific attributes are needed in the PW_MS along with a database of rules for the operation of the knowledge-system. Thus, the PW_MS is an algorithmic tool for project management which has a limited potential to be further developed into a composite information system.

9 CONCLUSIONS

Managing the PWP of the HKG is an exceptional challenge: the portfolio is large and diverse. The PWP-process involves a highly differentiated organization with the major roles of client, fiscal planner, portfolio manager and projects managers identified but not well executed. These circumstances are not unique to the HKG, management of large portfolios of project by a public-sector organization which acts as entrepreneur and agency for execution of the project is commonplace. The experience of the HKG is thus valid in the general case.

In these circumstances the MIS must cater to a more complex set of needs than existing software solutions provide. There is a need to manage portfolio information to serve, multi-project, multi-participant and multi-management situations. Open-systems analysis of the circumstances affecting the portfolio will identify the attributes of the projects which are truly significant in bringing about a high degree of success for the portfolio. It will also identify attributes of projects showing them to carry risk which jeopardize success or require management attention to mitigate risk. These vary dynamically as projects move through the development life-cycle, also as projects are added and deleted from the portfolio.

The complexity of the portfolio and its dynamics makes it essential to use a MIS to evaluate these situations and then to direct management attention towards those projects most significant in achieving the objectives of the portfolio as a whole. Existing MIS software is limited to the management of scope, cost and time aspects of projects. Portfolio management

includes a wider range of project attributes. Whilst each case is different our research shows that there is sufficient generality in the PWP case to serve as a model for other portfolios.

A combination of algorithmic data-processing, combined with a rule-based system of processing of data for resolution of those heuristics applying to the portfolio open-system is suggested as a more appropriate model for the MIS of the future.

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