The Evolution of Programme Management towards Governance of Industry 4.0 Organisations

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1. Introduction

Steyn and Semolic (2017, March) aver that the Fourth Industrial Revolution (Industry 4.0) is characterised by increasing digitisation and interconnection of products, value chains and business models. Competitiveness no longer depends solely on optimisation of own resources, but total inter-organisational value chain innovativeness and supportive partner technologies, products, services and systems. With the aid of partners, organisations are co-creating innovative inter-organisational value and supply chains that operate in a local, regional and international collaborative business ecosystem.

The complexity of today's technologies, artificial intelligence, mass data, robotics and internet of things calls for specialisation and sustainable collaboration among organisations. Consequently, organisational design, development and governance have entered a challenging new phase. This inevitably requires strategic transformation and change of Industry 4.0 organisations and demands the introduction of new horizontal supply and value chain business models. Virtual value chains shape organisations into strategic, collaborative, value-driven entities where non-core activities are performed by carefully selected partners.

A competitive edge is gained by collaboratively performing strategic activities more effectively and efficiently. This approach demands exceptional governance, supported by transformational leadership excellence and a systemic knowledge of applied programme management. Effective and efficient cross-functional and inter-organisational programme management of projects and programmes in virtual networks is a critical enabling competency for the Industry 4.0 economy. The advantages of programme management have become profoundly important in the Fourth Industrial Revolution economy.

In research done towards a Master's degree at Cranefield College, Zovitsky (2014) avers that by 1990 organisations already realised that competitiveness had become the driving force to win customer orders in project work. Competitiveness entails developing a business model that embeds sound project management methodologies and
techniques. Organisations realised that competency in project management constituted a primary input in planning and executing strategy with the ultimate purpose of creating sustainable competitive advantage. This required strong leadership initiative and support, and a firm belief that project management contributed to the bottom line of the organisation.

Rothwell (1994) identified that during the 1970’s and 1980’s organisations reoriented research and development (R&D) management to consolidate, readjust costing and shorten the path between knowledge and new technologies. Moreover, they started utilising matrix organisational structures. This ultimately led to incorporating project, programme and portfolio management into R&D management thinking. The focus was transferred from the product to the entire business system. Planning, production and product marketing were integrated into the entire process that enhanced systems, flexible innovation processes and networking models with customers and suppliers. This development was the forerunner of what is experienced today where leaders in the Industry 4.0 economy learning organisations focus on collaboration and the creation of virtual networks of partners to be more effective and efficient.

From the year 2000 project management maturity models and mechanisms assisted organisations to achieve rapid performance improvement. Several integrating mechanisms such as creating a formal hierarchy; standardising organisational policies and procedures; and introducing cross-functional teams emerged. These mechanisms were the forerunners of cross-functional project and programme-managed value chain structures utilised in modern day learning organisations.

2. Early Period Literature

Stretton (2009:3) argues that the terminologies ‘programme’ and ‘project’ have been used interchangeably since the 1960s and particularly in the US Department of Defence and NASA. There was no definite distinction between the usage of ‘programmes’ and ‘projects’ at that time, and large projects were often described as programmes. According to Weaver (2007), the Manhattan initiative to create the atomic bomb in the 1940s was probably the first programme, while since the 1950s numerous programmes crystallised in the US military. Milosevic et al (2007) mention that the Japanese implemented quality improvement programmes long before the United States. Quality project and programme management developed in the United States only in the early 1980s due to a dearth in America of quality management practices, which led to difficulties in competing nationally and internationally.

The 1970s was the period during which the focus moved to project control with the development of computer-based management systems capable of integrating cost,
time, and quality. Before that (the 1950s and 1960s) the emphasis was on the time span of projects and ways of reducing it. The result was that many organisations introduced integrated management systems in the early 1980s, but most of them still failed to deliver successful projects with regard to cost, time, and quality. According to Harpham (2003 [a]), this resulted in organisations looking for project managers who could manage in a matrix system with minimum “given” authority. The result was that organisations started paying increasingly more attention to the skills of project managers, inter-alia, leadership, motivation and team-building.

This led to competencies being a key discipline in the late 1980s and early 1990s. By the late 1990s the emphasis was on managers having good skills and knowledge in project management and organisations introducing strategic transformation and change project portfolios. This signalled the emergence of programme management in the project management domain. Figure 1 illustrates a graphic presentation of the development of project and programme management over the previous decades, as seen by Harpham (2003:2 [a]).

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*Figure 1: Development of Project and Programme Management (Source: Harpham, 2003:2[a])*

Harpham (2003) claims that programme management brings about the idea that managing projects is a form of change management, and that programme management is a disciplined approach to managing change in organisations. The focus then shifts from the project (or programme) itself to the delivering of the benefits of the project (or programme). At the start of the new millennium programme management and benefits delivery became high priorities in many organisations, rather than knowing when the project would be completed and at what cost (Harpham, 2003,[a]).
When practitioners started applying project management to more complex projects, the management of strategic objectives and the management of multiple interrelated projects, they realised the limitations of traditional project management techniques. According to Thiry (2010), studies done in 1996/97 found that up to 30% of all projects were cancelled before being completed. Traditional project management methods were identified as the reason for the failure to respond to emergency situations, ambiguity and the lack of integration between strategic intent and project deliverables. Around the same time programme management emerged as a distinct discipline. Thiry (2010:13) avers that this could be as a result of the maturing of project management and the development of “what the PMI has called Organizational Project Management”.

Stretton (2009) emphasises the confusion that exists generally between project management and programme management. The US industries kept programme management ‘secret’ for decades, and that is the reason for all the confusion around the understanding of what programme management really is. Milosevic et al (2007) assert that there were limitations even with the expansion of programme management in the 1980s. In some cases where the term ‘program management’ took root it was used to describe project management.

However, companies like Boeing and others in aerospace started applying the programme management discipline and model to all the divisions in their companies, since it proved to be very effective in the management of complex product development programmes. At the time practical knowledge about programme management practices and terminology only expanded as people moved away from these companies to others in the commercial sector. According to Milosevic et al (2007) the same situation still existed then as in the 1980s. Confusion with respect to project, programme and portfolio management still existed in many organisations, classrooms and literature.

In Wideman’s (2003) review of the 1st and 3rd edition of the Archibald (1976) book entitled: “Managing High-Technology Programs & Projects” he noted a shift in focus from the project manager as the single-minded and single-handed orchestrator of resources, to the dividing of responsibility on several levels. Another important shift was from the term ‘program’ as the “long-term undertaking [is] usually made up of more than one project [or] used synonymously with 'project', to programs and projects as strategic investments managed on a portfolio basis”. According to Wideman (2003): “this introduces today's fascination with portfolio management and concomitant advice on multi-project management under the direction of an enterprise-wide project management office”.

3. Intermediate Period Literature

In the 1950s programmes generally consisted of groups of projects that were inter-related, and generally only in the military/aerospace industries. Archibald contends that only since the 1990s has project portfolio management “emerged as an effective way to govern and manage groups of related projects” (Archibald, 2010:1). In 1976 the term ‘program’ was described as a “long-term undertaking” usually consisting of more than one project (or) used synonymously with a project. Wideman (2003:3) described programmes and projects as “strategic investments and management in a portfolio”. McElroy (1996) and Pellegrinelli (1997) describe a programme as a framework for grouping existing projects and/or defining new ones. They opined that these projects were managed in a coordinated way, either to achieve a common goal or to extract benefits, which would otherwise not be realised if they were managed independently.

From the above it is clear that programme management was seen solely in the context of a collection of projects. Pellegrinelli (1997) identified three types of programmes with the aim of making the concept more understandable. Each of these programmes is based on specific motivations for its creation:

- Portfolio programmes: A collection of projects managed in such a way as to extract certain benefits and for the transfer of knowledge and learning. These projects are seen as relatively independent of one another, but use common resources.

- Goal-orientated programmes: Execute changes through initiating, shaping, and integrating of multiple projects. The term also deals effectively with situations where uncertainty prevails and learning is a prerequisite for making progress. These programmes lend it to translate incomplete, emerging and evolving business strategies into tangible actions and new developments. That can be called strategic initiatives.

- Heartbeat programmes: Projects that enable the improvement of existing systems, business processes, and infrastructure. These programmes provide the integrative framework and processes for business requests for extra functionality, capacity, or changes to core processes.

Waddell (2005), citing Vereecke, Pandelaere, Deschoolmeester and Stevens (2003), argues that these classifications of programmes lack a “conceptual basis that allows us to understand why these three categories would be sufficient for describing and categorising all programmes”. Waddell (2005) refers to Cicmil’s (1997) perspective of project and programme management, which argues that project management has
changed its application to accommodate emerging management processes related to the implementation of organisational development and strategic change. Projects were becoming “a template for operational and strategic re-design”. This can be seen as a reference to programme management. From the above it is clear that up to the year 2000 programme management was still focussed solely on project portfolios. The initiative of applying programme management to the supply chain portfolio had not yet surfaced.

Murray-Webster and Thiry (2000) point out that programme management is the perfect methodology to ensure that strategic decisions are implemented successfully. In addition to projects, programmes include ongoing operations or support to projects. They argue that programmes will deliver benefits that could not be achieved if the projects in a programme had been managed independently of one another. The idea of a “more systemic view of organisations and learning organisation perspectives” is promoted, as well as, concurrent performance and learning loops in programme management that can be achieved through the introduction of value management techniques. Strategic decisions cannot be seen in isolation anymore. Their quality must be assessed with regards to their influence on organisational effectiveness that includes, among other things, customer satisfaction and sustainability. Why should organisations adopt a programme management approach? The answer to the question is that it’s about the controlled implementation of strategic decisions.

Thiry (2002) points out that strategic decision are seldom evaluated on their actual measured results, but rather on the conformity of the decision process or the satisfaction of the managers with their own decision. The biggest mistake organisations make is to treat programmes as large projects. He compiles a list of differences between projects and programmes that can assist organisations in using programme management has shown in Table 1. Thiry (citing Tsuchiya: 1997) states, “An unaligned organization is a waste of energy, whereas commonality of direction develops resonance and synergy”.

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<td>“Projects are aimed at achieving set deliverables with the least possible resources”.</td>
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<td>“Projects require a more ‘efficient’ approach”.</td>
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<td>“The project manager needs to be proactive and task focused”.</td>
<td>“The programme manager needs to be aware of strategic objectives and wide business benefits”</td>
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Murray-Webster and Thiry (2000) indicate three ways that organisations can shape their programmes of project portfolios:

- **Capital expenditure programmes.** “Capital expenditure programmes are highly prescriptive or specified and are grouped around common themes such as a business unit, specific groups of resources, or knowledge areas” (Murray-Webster and Thiry, 2000).

- **Strategic or goal orientated programmes.** “Strategic or goal-oriented programmes come about as a result of the planning, development and implementation of both prescriptive and emergent strategies. Strategic programmes are grouped around a common aim or purpose, such as a strategic objective where uncertainty exists about the final outcome, strategic scope changes occur, and projects and large tasks are added or removed accordingly” (Murray-Webster and Thiry, 2000).

- **Innovative (continuous improvement) programmes.** “Innovative (continuous improvement) programmes can be prescriptive or emergent and are grouped around a common platform, such as a process, business system or infrastructure that needs continuous enhancement” (Murray-Webster and Thiry, 2000).

Steyn (2001) adds a fourth initiative in the programme approach to the three ways cited by Murray-Webster and Thiry (2000), namely the programme-managed supply chain portfolio with a focus on customer service initiatives as shown in Figure 2. This programme is generally grouped around customer-service (internal and external) initiatives pertaining to the supply chain operational process, and focused on the different market segments within which the organisation operates.
Figure 2: Programme Managing the Organisation’s Value Chain - Illustrating the Project Portfolios and Supply Chain Process Portfolio (Source: Steyn, 2001).

Steyn (2001) avers that programme management provides an integrative framework through a collection of change actions (a programme is a collection of change actions that can be both projects and operational activities), which are purposefully grouped together to provide a vehicle to ensure that strategy is implemented. According to him the holistic programme management system illustrated above and in Figure 2, enables the effective and efficient management of the entire value chain. This includes the different portfolios of cross-functional project management processes, as well as the entire portfolio of cross-functional supply chain processes.

During the period 2001 to 2013 the programme management system illustrated in Figure 2 was the subject of further development and sophistication by Professor Pieter Steyn. He supports the view of the Global Supply Chain Forum of shaping the supply chain processes cross functionally. However, he differs with the approach of Lambert, Cooper, and Pagh (1998) who seem to use ‘old matrix management’ in an ad hoc fashion to manage the supply chain processes. Instead, he advocates the utilisation of programme management structures and principles for this purpose. The Steyn (2001) article is unique in that it constitutes the original idea of programme-managing the supply chain portfolio.
A more advanced business model of the one shown in Figure 2 was presented in a paper delivered by Professor Pieter Steyn at the 17th IPMA Global Congress held in Berlin, Germany, in 2003. The reviewed value chain schematic is shown in Figure 3 and depicts the three project management portfolios proposed by Murray-Webster and Thiry (2000) as well as an illustration of the portfolio of supply chain processes and its programme management structure originated by Steyn (2001). This value chain schematic also incorporates the Balanced Scorecard.

Programme management and portfolio management are often used as synonyms. Haughey (2001) distinguishes between the two concepts in the following manner, portfolio management gives a total view of all the projects undertaken in an organisation and ensures that the organisation remains focussed. He defines programme management as a group of related projects carried out to achieve a defined business objective or benefit. Control of this group of projects and project managers requires a programme manager. Portfolio management means all the projects, related or unrelated, being carried out by an organisation. This may be divided into functional areas, e.g. IT, Supply Chain, HR, etc. At this level the focus is on the direction of the organisation as a whole and not on individual projects or programmes. With this in mind, Figure 4 below illustrates how programme and portfolio management fit into an organisation (Haughey, 2001:6)
Harpham (2002) describes the differences between a programme and portfolio as follows: a programme automatically consists of a portfolio of projects, but not all portfolios of projects are programmes. Some projects are grouped together purely for resource or management coordination purposes, but they have no common strategic aim or goal, for example those managed by a contractor for his clients.

According to Haughey (2001:8-9), a growing interest in programme management developed owing to its ability to deliver strategic benefits to organisations, and ‘assist’ them to remain competitive in the global marketplace. In order to obtain the most from programme management, organisations should establish processes that will enable them to leverage maximum benefit from what is a fairly new technique. In this context, a programme management framework is defined as bringing project management under control and ensuring that there is a focus on delivering the strategy of the organisation as opposed to the technical delivery of individual projects. It consists of eight key areas:

- **Vision**: High level strategy or idea to drive the organisation towards a goal;
- **Aims & Objectives**: This is a more detailed statement that explains what exactly is required;
- **Scope**: Gives boundaries to the programme explaining what exactly it is that will be delivered;
- **Design**: This is the way in which the projects that make up the programme are put together;
- **Approach**: This the way the programme will run;
- **Resourcing**: Looks at the scheduling and allocation of resources;
- **Responsibilities**: Identifies and allocates responsibility for each area in the programme; and
Benefit Realisation: Is the process by which the deliverables of projects and cross-functional processes are measured, appraised, and reviewed in order to determine to what degree benefits of strategic importance are achieved.

The programme management framework of Haughey encompasses all the project-process-portfolio elements and provides:

- A focus on delivering major organisational changes or benefits;
- Greater control through visibility of all projects in the programme;
- An understanding of project dependencies;
- Clearly defined roles and responsibilities;
- A single line of communication to the steering committee or sponsor;
- Optimised use of resources across projects;
- Ability to leverage economies of scale and maximise value;
- Management of risk across related projects; and
- Mechanisms for measuring benefit realisation (Haughey, 2001:10).

Haughey identified four stages of programme management that organisations can apply to create an effective environment in which they can monitor and control the progress of their programmes, namely:

- Programme Identification;
- Programme Planning;
- Programme Delivery; and
- Programme Closure.
In the programme identification phase/stage that takes place at strategic (portfolio) level, the programme mandate is translated into a *programme brief*. The programme is defined in terms of its set-up and the desired benefits to enable management decision-making on whether the programme is justified.

The programme planning stage is where the programme management team undertakes the detailed planning and initiation of the various projects that make up the programme.

In the programme delivery stage the individual projects are taking place under the control of each Project Manager. At this stage the activities of the programme manager focus on alignment and managing shared resources.

During the programme closure stage, programme management activities are focused on achieving desired business objectives or desires. As a final task, the programme manager should review the entire programme and document any lessons that have been learnt that can be of help with regards to enabling future programmes to run more effectively.

Haughey (2001:13) stresses that these stages can improve the chances of bringing programmes to successful conclusion, but he still concentrates only on project portfolios. Programme management exists to bridge the gap between corporate strategy and projects and, thus, enable an organisation to decide whether a project fits into its strategy or not. There can be more than one programme coexisting in parallel with a key executive or board member responsible for each programme. These programmes collectively make up the strategic plan designed to deliver the vision for the organisation.
Haughey argues that a management organisation structure with clearly defined key roles and responsibilities is important for projects as well as programmes, with a programme manager to coordinate the projects within the programme. In the past, the project manager was accountable for all the roles, but he asks the question, “What about the benefits?” The classifications of programmes of Vereecke et al (June 2003:5) are based on two dimensions. What the business impact of the programme is, and to what extent the projects exist at the launching of a programme. This results in four distinct types of programme:

- **Type A-programmes:** A group of several existing projects each with relatively limited business impact, relatively independent initiatives, set up in different parts of the organisation, and brought together under the new programme. The goal of the programme is to benefit from the synergies among these projects realising that the projects share some common objectives.

- **Type B-programmes:** A group of several existing projects each with high business impact. The risk of going into very different directions with the existing projects dictates the need for timely integration of these projects into a unified programme.

- **Type C-programmes:** With the launch of these programmes no projects associated with the objectives are being carried out in the company. These programmes start “from scratch” as new initiatives with relatively limited impact. As the programme is initiated, the portfolio of projects that are part of the programme is defined.

- **Type D-programmes:** No projects associated with the objectives of the programme are being carried out in the company. These programmes start “from scratch” as new initiatives with high, business-wide impact. As the programme is initiated, the portfolio of projects that are part of the programme is defined.

In 2003/2004 Martinelli and Waddell emphasised the importance and application of programme management. They defined a programme manager’s responsibilities as follows:

- Establish the programme core team;
- Define its structure and scope; and
- Communicate the programme objectives and be responsible for the financial, business and other deliverables for the programme.

Martinelli and Waddel (2003: 6) found that general managers cannot manage the investment of all product development efforts of the organisation, and they realise that programme managers are needed. In recent years the project management discipline accommodates emerging management processes related to the implementation of organisational development and strategic change, in contrast to the traditional project management approach of an exclusive management process of a scientific nature.
This inclusion of project management into the general organisation is essentially a reference to programme management.

Martinelli and Waddell (2004) state that the primary roles of the programme manager are the following:

- Firstly, to manage the business of the programme to ensure that the return and other business objectives are achieved.
- Secondly, the programme manager is responsible for leading multiple project teams through the product development life cycle. “The key challenge for the program manager during the development life cycle is managing the interdependencies between the project teams and ensuring the project efforts remain in synchronization - if one project fails, the entire program fails.”

According to Martinelli and Waddell (2004), the three most important differences between programme and project management are the following:

- Programme management is strategic in nature, while project management is practical in nature;
- Programme management is entirely cross-functional, while project management focuses on a single function; and
- Programme management integrates the individual elements of the projects in order to achieve a common objective (Martinelli and Waddell, 2004:1[c]).

Characteristics of programme management, according to Martinelli and Waddell (2004), are:

- “A program is strategic in nature. Program management ensures the program is closely aligned to and directly supports the achievement of a business’ strategic objectives.
- Program management provides a focal point for ownership and accountability for successfully delivering the intended business results for the organization.
- A program has both business and technical focus. Program management ensures the program is successful in both aspects.
- Each interdependent project within the program has a set of objectives.
- Program management ensures that project objectives contribute to the achievement of the business goals of the program.
- A program normally incorporates both cross-functional and matrix forms of organisation.
- Program management is the glue that holds the matrix together, ensuring that the functions perform as a cohesive team. Organizationally, program management provides the opportunity to manage effort across the traditional line structure, contributing to faster decision-making and improved productivity.
- A program is led by a program manager who is responsible for the characteristics above”.
Michel Thiry (2004) developed a programme lifecycle called For DAD (Formulation, Organisation, Deployment, Appraisal and Dissolution) and it differs from a project lifecycle because programmes have a different purpose and approach from those of a project.

- **Formulation** – development of possible courses of action, and determine certain benefits;
- **Organisation** – planning of strategy and selection of best actions;
- **Deployment** – execution of actions and control thereof;
- **Appraisal** – assessment of benefits and change/improvement if required; and
- **Dissolution** – re-allocation of people and funds.

All the above terms reflect a long-term strategic endeavour, representative of a programme’s nature.

Carter (2005) noted that programme management is more than a collection of projects acting independently and managed together. Programmes are different from projects. With programmes it is the outcomes that matter, not their outputs. Outcomes that affect behaviours are the result of change. Successful management of programmes in an organisation helps to define where such an organisation is heading, and the way to get there. Effectively and efficiently to manage and deliver the organisational results can be possible only when programme management becomes a relevant part of an organisation. If an organisation’s project and programme management is weak, how can it ever achieve the full potential of portfolio management?

### 4. The Recent Period Literature

Brittingham (2006) believes that the roles of project and programme management must be clarified since effective project management can be achieved only in those organisations that make project and programme management distinct career paths within their organisations. In **project driven organisations** communication from management about the various roles is important for success. Programme success depends on the successful execution of the projects within such a programme. Consistency in project delivery is crucial, and a consistent approach to project management is paramount.

According to Shehu and Egbu (2008 [a], citing Partington et al, 2005) project management has grown in recognition, and a wide variety of organisations accept project management ranging from the original engineering projects to a broad spectrum of human endeavours. Organisations realise that success resides in the ability to manage such projects effectively, and that can be achieved only by managing a portfolio of related projects. They argue that programme management has its origin in this perspective, and sound a warning that it is essential that caution is exercised in selecting the skills and competencies between the two disciplines. Programme management competence is not simply an extension of project management competence, but it “requires a subtle blend of interpersonal skills and personal
credibility, a deep understanding of the political dynamics of formal and informal networks of the programme and affiliated projects”.

The authors (citing Partington et al, 2005, and Pellegrinelli et al, 2007) argue that corporate leaders know that to promote proven project managers into roles as programme managers can be unreliable but suggest that most current programme managers were project managers that were promoted. This does not, however, spell success even if the project management skills are relevant and applicable in programme management. It is essential that caution is exercised in selecting the skills and competencies between the two disciplines (Shehu and Egebu, 2007:7).

According to Pellegrinelli (2008), little research was done into programme management before 2002. He noted that individuals involved in traditional project management struggle to understand the unique nature of programme management. The problem such individuals have is that, although programmes are bigger and more complex than projects, they believe the same basic approach and technique can be applied to the management of a programme. Even a shift in focus from output to outcome as a distinguishing feature is incorrectly perceived by them as hardly new!!! Moreover, they argue that programmes simply represent “another level in a pyramid of increasing scope and complexity”.

Pelligrinelli (2008:4) avers that programme management is a high-profile approach in all sectors, public and private, especially financial services, telecommunications, defence, and aerospace. Its global prominence is in part due to the success of project management. The need to achieve elusive benefits and control can be possible only by coordinating both project and non-project work. By non-project work the author probably refers to other supply chain processes. To distinguish this activity from core project management has often been referred to as “programme management”. Programme managers involved in programmes intended to transform large organisations or in complex strategic initiatives have to cope with ambiguities of strategy, environmental turmoil, cultural tensions, and even political undercurrents. An experience programme manager will feel responsible for delivering not only the mandated changes, but also for the growth, renewal and vitality of their organisations. As Pelligrinelli (2008), (citing, Maylor et al, 2006), notes: “Programme management has many incarnations and is still taking shape as a formal discipline”.

According to Gartner Consulting (2009), too many projects fail, and the implementation by a third party expert of critical programme management can provide formalised, holistic supervision of crucial projects. They emphasise the importance of customer relationship management (CRM) and enterprise resource management. The IBM Corporation (2008) did a study to determine the opinions of 1000 CEOs about the enterprise of the future. They all agreed that organisations are bombarded by change, that many organisations struggle to cope with transformation, and that the gap between expected change and the ability of organisations to manage the required transformation has almost tripled since the previous study done in 2006.

Stretton (2009) notes many diverse understandings of the nature of programmes and projects. The reason is that a great deal of misunderstanding about the meaning of
programmes, projects, programme management and project management exists. Programme management is seen mostly as a coherent set of management processes and practices. According to Pellegrinelli (2010:2), a distinct programme management model can provide an alternative way of shaping change initiatives, and it can co-exist with and complement traditional project management approaches within organisations. Project and project management have become on-going features in many organisations, where the extensive use of projects has brought a perceived need to coordinate and balance their diverse interests and priorities. He argues that in complex organisations top management must facilitate managerial sense making and control through “programmes and portfolios where project are the principal units of work”.

Stretton (2010) contends that programmes and projects are different. His research makes it clear that in future programme literature the focus should shift to “program-distinctive attributes”. He stresses that that the literature contains diverse perceptions regarding the origins of projects, programmes and portfolios, and the decision by an organisation to adopt the concepts depends on needs that cannot be satisfied through normal operational processes. Moreover, it is important to understand how projects within a programme relate to one another. Without this knowledge difficulties arise in managing relationships in an integrated and coordinated way. Literature on programme management should focus on how to manage programmes. The factors distinctive to programme management should be identified and then discussed in detail. He contends that programme distinctive attributes receive too little attention in the literature.

According to Pellegrinelli (Feb 2010), there has been (and still remains to some degree) an implicit, yet widespread view within the project management practitioner and academic communities that programme management is part of, or an extension of, project management. Sceptics argue that this is a narrow conception of project management and that managing a megaproject has much in common with managing a programme. Maylor et al (2006), (in Pelligrinelli, March 2010: 2), propose that in complex organisations top management must facilitate managerial sense-making and control through programmes and portfolios where projects are the principal units of work. Others, like William and Parr (2004) and Gaddie (2003), advocate a concept of “enterprise programme management” meaning “structures and processes creating tight linkages between organisational strategy and the totality of its projects and related change activity”. The benefits from this are a better deployment of resources and greater clarity and control over spending. Through enterprise programme management an organisation can improve its chances of realising its strategies and achieving the desired returns from its projects and programmes (Pelligrinelli, March 2010: 2).

Price Waterhouse Coopers (2006) conducted a survey in representative organisations from 26 countries with the aim to identify the current trends in project management, and detected an increase in the focus on building portfolio management capability. They found that there was an increase of 7% in organisations that adopted portfolio management structures since 2004. They concluded that portfolio management was becoming increasingly important in providing up-to-date views of an organisation’s entire project portfolio, and to determine whether such portfolios are aligned with set strategic goals. Moreover, they concluded that the quality of programmes in portfolios
and the delivery of strategic benefits were becoming increasingly important in the 21st century (Price Waterhouse Coopers, 2006: 27).

According to Ainsworth (2009:3), organisations need to implement a portfolio management approach in order to select appropriate programmes and projects. The benefit of such a disciplined portfolio management approach is that the organisation's programmes and projects are more likely to be aligned with the organisation's strategy and produce a wider organisational value rather than a perceived value for a single functional operation. Such organisations become more capable in deciding how to stop or reprioritise programmes or projects which are not producing the original business value.

Archibald (2009) correctly argues that it is time that people realised there are more project categories than they generally refer to. People tend to refer to a few categories only when they write about projects and project management, and they assume that their ideas apply equally to all categories of projects. “Until we have an agreed, globally accepted, systematic method of categorizing projects for each of the several purposes for which we actually do categorize them in a de facto manner, we will continue to act just like the blind men and the elephant” (PM World Today, Featured Interview – January, 2009, Part 4: 9).

According to Archibald (2010:4), there are six important portfolio management processes and related responsibilities:

- “Select and authorize new projects and programs to be added to the appropriate, currently active project portfolios within the organization;
- Validate that each selected and authorized project and program properly supports the currently approved strategic objectives of the organization;
- Prioritize all validated projects and programs within each established project portfolio to facilitate proper allocation of money and other key resources between these 'portfolio components';
- Allocate key resources (money, skilled people, equipment, facilities, other) to each portfolio and each project and program therein;
- Establish the master schedule for each project portfolio reflecting the established priorities and the approved allocation of money and other key resources to each project and program; and
- Cancel or change the scope, schedule, end result, and cost of approved projects and programs when such actions are required or justified".

Archibald (2010) believes that all of the abovementioned processes and related responsibilities are strategic management responsibilities, except the second last: “Establish the master schedule for each project portfolio reflecting the established priorities and the approved allocation of money and other key resources to each project and program”. This falls within the “usual domain of the project management discipline”. He argues that Project Portfolio Management (PPM) provides the bridge between strategic and operational project management and that it “makes more sense to define more than one portfolio on a strategic basis in a large organisation".
In an article entitled: “The Need for a Chief Portfolio Officer (CPO) in Organisations”, Steyn (July 2010) presents a programme-managed portfolio system that constitutes an improvement in the value chain schematic originally proposed by him in 2001 and revised in 2003. The system inculcates programme management of an organisation’s portfolios of cross-functional value chain processes that encompass the supply chain portfolio and project portfolios. Four project portfolios and the cross-functional processes of the supply chain portfolio are included, all aimed at enhancing the effectiveness and/or efficiency of the value chain. The project portfolios are: strategic transformation; innovative continuous improvement; capital expenditure; and product development virtual network of partners. Importantly, Steyn (2010) emphasises that the supply chain portfolio of cross-functional processes differs in structure depending on whether an organisation utilises a project-driven or a non-project-driven business model.

Published in “PM World Today”, the Steyn (July, 2010) article received the following positive response from Dr Russ Archibald: “Professor Pieter Steyn’s featured paper (with this title) in the July issue of PMWT is an important contribution to our PM literature on several counts. Steyn’s arguments are very persuasive to me. Among many statements and concepts that I am tempted to quote, here are a few of the most important, in my view:

- Partington deplores the fact that strategy literature concentrates on theories about how best to formulate and plan strategy, while at the same time underestimating the difficulty of developing and implementing strategy at the corporate, business and operational levels. He contends that organizational transformation and change can best be achieved through programme management structures and paradigms.

- Steyn proposes four project portfolios within a “Balanced Scorecard Programme Management Learning Organization”: 1) Strategic Transformation; 2) Virtual Network of Partners; 3) Continuous Improvement; and 4) Capital Expenditure.

Steyn quite rightly points out that the concepts of "programme (or program) management" have evolved significantly in recent years. He quotes the 2009 Gartner Research findings that PMI's 2008 ‘Standard for Program Management' demonstrates little understanding that the two disciplines of programme management and project management, although related, are distinctly different. Programmes are mistakenly seen by the collection of authors of the PMI document as 'simply overly large projects.’ Unfortunately, the vast majority of existing publications on the subject of portfolio- and programme management suffer from similar deficiencies. Steyn also describes his and others’ efforts to "comprehensively address these deficiencies and put modern thinking, including the emergent role of the Chief Portfolio Officer, into perspective." (Archibald, August 2010)

According to Pelligrinelli (2008:4), programme management enjoys a high-profile approach in all sectors, public and private, especially financial services,
telecommunications, defence and aerospace. Its global prominence is in part due to the success of project management. The need to achieve elusive benefits and control can be possible only by coordinating project and non-project work. To distinguish this activity from core project management it has often been called “programme management”.

Steyn (2010, 2012 and 2013) is of the opinion that the internal and external environments of organisations have become much more volatile since the beginning of the current decade. The urgency to structure non-project operations cross-functionally has become increasingly important as organisations struggle to escape bureaucratic practices and transform towards becoming learning entities in the Industry 4.0 economy. Doing this successfully will sustain competitive advantage, and requires continuous improvement of human talent, knowledge, skills and behaviours.

As illustrated in Figures 6 and 7, several types of cross-functional project and supply chain portfolios exist in the modern learning organisation value chain. The project portfolios are strategic transformation, innovative continuous improvement, capital expenditure and (as proposed by Semolic, 2009 and 2010) a virtual network of partners, all serving internal customers. Steyn (2012 and 2013) avers when organisations utilise a project-driven business model, the supply chain portfolio contains a further project component, i.e., the programme office serving external customers for whom the projects are performed. Organisations employing a non-project driven business model are not engaged in project work for external customers, and the supply chain portfolio does not contain this project component. Moreover, it does contain a cross-functional project process for product development and commercialisation.

The balanced scorecard-based value chain schematic illustrated in Figure 6 is depicted in its organisational structure form in Figure 7. It includes the important position of Chief Portfolio Officer at the executive level proposed by Steyn (2010). In addition to the project portfolios recommended by Murray-Webster and Thiry (2000), i.e., (strategic transformation, continuous improvement and capital expenditure), and the product development virtual network of partners project portfolio (Semolic, 2009 and 2010), Steyn (2001 to 2013) adds the “project driven and non-project driven business model supply chain portfolios”.

![Programme Structures Diagram](image)

**Figure 7: Portfolio and Programme structures for the various project and supply chain groupings (Source: Steyn, 2010).**

The Strategic Transformation and Change Project Portfolio focuses on strategic analysis, strategic development and strategy implementation. This portfolio targets the implementation of strategies to enhance organisational effectiveness by doing the right things. Project deliverables aim to bring about organisational transformation and change in the organisation with respect to behavioural, structural and operational dimensions. The primary goal is to improve value chain performance. As the organisation matures towards becoming a learning organisation the tasks of the programme-managed strategic transformation and change office progressively diminishes (Steyn, July 2010, 2012 and 2013).

Projects constituting the Innovative Continuous Improvement Portfolio result from business initiatives and organisations following an innovative continuous improvement policy are continuously engaged in continuous development and upgrading of processes, infrastructure, technology, systems and human talent. This is in total contrast to bureaucratic organisations that generally fail to adhere to quality management principles, resulting in them losing their competitiveness. Continuous
improvement projects are about doing the right things and doing things right the first time (Steyn, July 2010, 2012 and 2013).

The Capital Expenditure Portfolio consists of capital investment projects that are highly prescriptive or specified. Benefits resulting from these activities include better prioritisation and control over multiple projects and ensuring better allocation and utilisation of resources, as well as appropriate identification and control of dependencies between the projects. The main gain is improved organisational efficiency. Projects delivering the best benefits are assigned the highest priority with respect to implementation and result in improved organisational efficiency. (Steyn, July 2010, 2012 and 2013).

The Virtual Network of Partners Portfolio for specialised product development is a relatively new concept focused on technological innovation projects. Synergy in the monitoring and controlling of operations within the organisation is very important. The virtual network of partners projects serve to stimulate product innovations and lead to improve competitiveness. According to Semolic (2009 and 2010), the emerging virtual network of partners structure is cross-functional with project managers reporting to a programme manager. Excellent leadership abilities and effective and efficient governance of the virtual network of partners organisation are essential. Moreover, partners must be carefully selected and the role of each partner organisation in the virtual network must be clearly defined (Steyn, 2010, 2012 and 2013).

Organisations increasingly realise the importance of creating virtual networks of partners that can serve to stimulate product development innovations and lead to improved competitiveness. Semolic (2010) emphasises the importance of effectively and efficiently managing virtual networks of partners as an important component of the modern day supply chain. Extended functions of the supply chain, such as demand planning, supply planning, manufacturing, supply chain visibility and supply chain network optimisation can enable collaboration with partners and can stretch the processes at either end of the corporate supply chain.

According to Semolic (2010) and in line with what is now known as Industry 4.0 thinking, modern organisations realise the advantages of focusing on their core competencies and create networks of clusters. These organisations need to analyse their business activities and global markets on a continuous basis, while searching for new business models to improve their organisational capacities. Virtual networks are based on the utilisation of modern information and communication technologies, as well as collaboration between the partner resources. It is necessary that all participants espouse the same values and display the same research, development, and business interests.

The eight key processes that encompass the core of supply chain management as identified by the Global Supply Chain Forum are as follows:

- Customer relationship management (CRM);
- Customer service management (CSM);
• Demand management;
• Order fulfilment;
• Manufacturing flow management;
• Procurement;
• Product development and commercialisation; and
• Returns.

Steyn (2001 to 2013) supports the view of shaping the supply chain processes cross-functionally as proposed by the Global Supply Chain Forum (1998), but points out that the Forum’s focus is on the non-project driven business model organisation. He distinguishes between non-project driven business models and project driven business models, and avers that the supply chain portfolio of the project driven business model organisation includes the component of doing projects for external customers. Moreover, he points out that the project management processes comprising this component include all the product development and order fulfilment activities. He also differs from the approach of Lambert et al (1998) with regard to using ‘old matrix management’ in an ad hoc fashion to manage the supply chain. Instead, he advocates the utilisation of programme management structures and paradigms.

Steyn (2012 and 2013) avers that three different business models can be adopted by organisations, i.e., a project driven business model; a non-project driven business model; and/or a hybrid of the two. The non-project driven business model organisation generates income by selling products and services to external customers. In a learning organisation structure, the cross-functional supply chain processes as proposed by the Global Supply Chain Forum are all present. However, only the ‘product development and commercialisation’ process is project-based, the others being normal operations processes. According to Steyn (2012 and 2013), the resulting matrix structure of the supply chain portfolio, as illustrated in Figures 8 and 9, must be programme managed. Moreover, he argues that ‘order fulfilment’ and ‘returns’ should be combined into a single operational process.
Figure 8: Non-project driven Business Model Value Chain Schematic

Figure 9: Non-project driven Business Model Supply Chain Structure
(Source: Steyn, 2012 and 2013)
The project driven business model organisation generates income by doing projects for external customers accrued through tenders or bids. A project-based cross-functional structure serving external customers and incorporating ‘product development and commercialisation’ as well as ‘order fulfilment’ now forms part of the architecture. The remaining operational processes still form part of the cross-functional supply chain portfolio. According to Steyn (2012), the resulting matrix structure of the supply chain portfolio, as illustrated in Figures 10 and 11, are managed through programmes. Moreover, in the project driven organisation ‘returns’ mean that the project deliverable is rejected, normally resulting in serious consequences.

![Image of Project Driven Business Model Value Chain Schematic](source)

**Figure 10: Project Driven Business Model Value Chain Schematic**
(Source: Steyn, 2012 and 2013)
Steyn and Semolic (2016 and March, 2017) aver that in governance of virtual networks of partners, leadership and management are of paramount importance in the Fourth Industrial Revolution economy. Excellent leadership abilities are required all round. Knowledge of and experience in differentiation, integration, coordination and collaboration of networking activities are management skills that lead to success. The same can be said for the ability to gain appropriate resources from the initiating partner and the participating organisations for operating the virtual network. Moreover, all participants in a virtual network must possess high levels of project management maturity and be exceptionally proficient, skilled and experienced in the essential programme management skills required for the task.

Semolic and Steyn (September, 2017) opine that governance in virtual networks of partner organisations in the Industry 4.0 economy should be effectively and efficiently integrated and co-ordinated by the initiating organisation applying state-of-the-art programme management. Moreover, governance of the portfolios of programmes, including the virtual networks, should be directed and managed by a Chief Portfolio Officer (CPO) at the executive level as proposed by Steyn (July, 2010) and strongly supported by Russ Archibald (August, 2010). The importance of programme-managed business models, *inter alia*, virtual networks of partners, project driven and non-project driven business models and the introduction of a CPO are profoundly important in the Industry 4.0 situation.
Basu (2011) contends that supply chain management is the key interface between operations and projects. Where supply chain activities were traditionally seen as separate functions, it is now perceived as a single process integrated across all the functions of the organisation. In line with Industry 4.0 reality he views the integrated supply chain approach as effective and efficient, and believes it vital for organisations to partner with local, regional and global resources while working in harmony with all stakeholders. This requires a holistic value stream or total supply chain management approach.

5. Conclusion

The above research clearly illustrates how programme management has evolved over the decades towards becoming the kingpin for leading, managing and governing Industry 4.0 entities. Moreover, the above cross-functional programme-managed structures and paradigms combined with effective and efficient transformational leadership, management and governance is the ideal vehicle for delivering the integration, coordination, collaboration and synergy required for mitigating complexity and risk, while achieving essential organisational performance, strategic benefits and value add in the Industry 4.0 environment. Based on the research presented in this article the current authors advocate the adoption of all portfolio and programme structures in the modern organisational value chain, supported by integration, coordination and collaboration utilising programme management. This is of profound importance in the Industry 4.0 economic environment.

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